

WILL FILE COPY



2

Office of the

Chief of Naval Education and Training

NAVEDTRA 115-1

Washington, DC 20340-5100

September 1988

# WHAT WORKS

*Summary of  
Research Findings  
with Implications for  
Navy Instruction and Learning*

AD-A200 804

*Prepared by the  
Navy Personnel Research and Development Center*

*Published by Direction of  
Chief of Naval Education & Training*

Approved for public release; distribution unlimited.

DTIC  
ELECTE  
OCT 31 1988  
S D

88 10 21 042



DEPARTMENT OF THE NAVY  
CHIEF OF NAVAL EDUCATION AND TRAINING  
NAVAL AIR STATION  
PENSACOLA, FLORIDA 32508-5100

September 1988

**Letter of Promulgation**

1. This document provides summaries of extensive research on instruction and learning of relevance to the NAVEDTRACOM. It lists actions that might be undertaken to insure excellence in Navy instruction, and summary statements from research that support such actions.

2. This **Summary** is intended to be used by all NAVEDTRACOM activities, to provide information to support practices and planning for attaining excellence in instruction, and to support in-service training, instruction, and instruction development.

3. Comments and corrections concerning this publication should use the space provided on the form contained on the last page of this document and sent to the address included.

4. Reviewed and approved.

N. R. THUNMAN

Distribution (CNETINST 5218.2B, Case A):

List I; IV - VII

NETPMSA

NETC

OPNAV

CINCPAC

CINCLANT

CHNAVRES

COMNAVRESFOR

NAVSEASYS COM

NAVAIRSYS COM

NAVSPAWARSYS COM

NTSC

HSE&TCOM

NAVPGSCOL

HQ USMC

HQ TRADOC

HD ATC

**WHAT WORKS:**  
**Summary of**  
**Research Findings**  
**with Implications for**  
**Navy Instruction and Learning**

Prepared by  
William E. Montague, Ph.D.  
Navy Personnel Research and Development Center  
San Diego, CA 92152-6800

Reviewed by  
Joseph Haslett, Ed.D.

Published by Direction of  
Chief of Naval Education & Training  
Pensacola, FL 32508-5100

## Preface

Chief of Naval Education and Training

Pensacola, Florida

September, 1988

Training and education are vital to maintaining Navy preparedness. From my view, most military operations in peacetime are directly linked to training. It is the backbone of Navy combat readiness.

We take graduates of the American educational system and quickly turn them into a highly technical fighting force. The constantly increasing technological complexity of our weaponry, and the capabilities of our potential enemies make the task difficult, the costs great, and the need for training efficiency and effectiveness crucial.

*What Works: Summary of Research Findings with Implications for Navy Instruction and Learning*, provides practical information for individuals serving different roles in training and educating Navy personnel. It is part of our initiative to bring about widespread application of instructional practices found to be effective in schooling. This book represents a synthesis of the best available information about instruction available from decades of research studies and teaching experience.

I am confident that by attending to these findings the quality of Navy training can be improved and the proficiency of Navy personnel kept at the highest level. Maximizing personnel proficiency and readiness by providing quality training is of utmost importance in the face of challenges to our country. I believe this book represents an important step in transferring the knowledge we have gained from both military and civilian research and development into practice, and for improving the quality of Navy education and training. Use it!



N. R. Thunman

|                    |  |
|--------------------|--|
| Accession For      |  |
| NTIS GRA&I         | <input checked="checked" type="checkbox"/> |
| DTIC TAB           | <input type="checkbox"/>                   |
| Unannounced        | <input type="checkbox"/>                   |
| Justification      |  |
| By                 |  |
| Distribution/      |  |
| Availability Codes |  |
| Dist               | Avail and/or<br>Special                    |
| A-1                |  |



## FOREWORD

Joseph E. Haslett  
Senior Educational Specialist  
Naval Education and Training Command

---

This report is addressed to those Navy personnel involved in all aspects of Navy education and training. It is intended to provide summarized information based on a synthesis of research in an easily understandable, accurate form about *what works* in educating and training young adults. It is meant to provide a source of information to guide training executives who manage and make policy, instructors, and training specialists who are curriculum designers, developers and evaluators.

The preparation of this book was precipitated in part by a similar document produced by the Department of Education<sup>1</sup>. That document has become the most widely distributed document on instructional research ever. It was directed primarily at parents and teachers of young children attending schools of the Nation. Obviously, Navy education is different than elementary and secondary education. Our students are young adults, volunteers choosing careers in the Navy. Therefore, the focus of this document is on instruction for various Navy careers.

The information in this volume is a distillation of experience and a large body of scholarly research in education, military training, and vocational education and training. We trust it is a useful distillation. It is, of course, a selective one. It consists of discrete findings about teaching and learning that may be applicable in Navy classrooms, on ships, in instructional development, and in planning changes in how instruction will be done in the future. In some cases, the findings simply support what is recommended practice. In others, it may provide new guidance to assist current training or planning for the future.

This volume is a "first cut" and so, there are instructional and policy issues that are not addressed here. A second edition is planned in which we will try to remedy any deficits based on feedback from users and other interested parties. During 1988 we will conduct workshops and

other field exercises in Navy training environments to gather first-hand information for the revision.

The book makes available a synthesis of the information from research and evaluation that we are confident can make improvements in the quality of training for Navy personnel if properly applied. Primary responsibility for assembling the material in this volume was borne by Dr. William Montague, Senior Scientist in the Instructional Technology Department at the Navy Personnel Research and Development Center, and his Navy and civilian advisors. In the introduction that follows, he describes the process used in developing the material and the context of instructional technology in which this all fits.

Many of you will find the recommendations surprising because they seem to be just common sense. What is common sense is not necessarily common practice. We don't always find them being applied in Navy classrooms and development centers. Our goal is to bring about universal application of practices that we know will improve the achievement of our students and, ultimately, their job proficiency and readiness.

We are confident that Navy instructors, training executives, and training specialists are willing and able to improve the schools, and the quality of training generally. Properly applied, the information in this book can assist in the process. Armed with good information, we can upgrade quality and student achievement. As should be clear from this book, there is much that can be done.

Comments and constructive suggestions are welcome for future efforts and revisions of this document. Please use the page provided at the end of the volume to make your comments and to suggest improvements in the coverage.

<sup>1</sup>W. J. Bennett (1986). *What works: Research about teaching and learning*. Washington, DC: U. S. Department of Education.

# CONTENTS

|   | page      |
|---|-----------|
| Preface .....   | ii        |
| Foreword .....  | iii       |
| Introduction .....  | 1         |
| <b>A Plan for Achieving Excellence in Navy Training .....</b> | <b>4</b>  |
| For Training Executives.....                                  | 4         |
| For Instructors.....  | 5         |
| For Training Specialists.....                                 | 6         |
| <hr/>   |           |
| <b>Research Findings About Instruction and Learning for:</b>  |           |
| <b>Training Executives .....</b>                              | <b>7</b>  |
| School Learning Environment .....                             | 8         |
| Managing Instructors .....                                    | 9         |
| Evaluating and Supervising Instructors .....                  | 10        |
| Managing Student Learning .....                               | 11        |
| Monitoring and Tailoring an Instructional System .....        | 12        |
| Course Evaluation and Revision .....                          | 13        |
| Initiating the Working Environment for Learning .....         | 14        |
| Maintaining Skills and Knowledge .....                        | 15        |
| Students-Instructor Ratio Tradeoffs .....                     | 16        |
| Managing Informal Learning .....                              | 17        |
| Planning Changes in Conducting Training .....                 | 18        |
| Cost Effectiveness .....                                      | 19        |
| Structuring Instruction.....                                  | 20        |
| Computer-Based Instruction .....                              | 21        |
| Video Technologies for Instructing .....                      | 22        |
| Training Devices for Task Simulation and Practice.....        | 23        |
| Distributed Instruction.....                                  | 24        |
| Adopting Training Innovations .....                           | 25        |
| <b>Instructors .....</b>                                      | <b>26</b> |
| Rating Instructors .....                                      | 27        |
| Instructor Classroom Role.....                                | 28        |
| Instructor Classroom Leadership .....                         | 29        |
| Teaching Students How to Learn .....                          | 30        |
| Testing Student Learning .....                                | 31        |
| Giving Feedback to Students .....                             | 32        |
| Managing Class Time .....                                     | 33        |
| Cooperation in Learning .....                                 | 34        |
| Peer Teaching .....   | 35        |
| Instructor Presentation Stimulates Learning.....              | 36        |
| Practice.....   | 37        |
| Promote Development of Mental Models .....                    | 38        |
| Motivating Students .....                                     | 39        |
| Student Control of Learning .....                             | 40        |
| Out-of-Class Assignments.....                                 | 41        |

|  |    |
|--|----|
| <b>Training Specialists</b> .....  | 42 |
| <i>Systematic Approaches to Training Design</i> .....                    | 43 |
| <i>Training Objectives</i> .....   | 44 |
| <i>Writing Text Materials</i> .....                                      | 45 |
| <i>Readability of Training Materials</i> .....                           | 46 |
| <i>Learning Built on Knowledge</i> .....                                 | 47 |
| <i>Using Examples and Nonexamples</i> .....                              | 48 |
| <i>Motivating Student Learning</i> .....                                 | 49 |
| <i>Designing Effective Illustrations and Graphs</i> <sup>a</sup> .....   | 50 |
| <i>Formative Evaluation of Instruction</i> .....                         | 51 |
| <i>Using Simulation for Training</i> .....                               | 52 |
| <i>Criterion Referenced Testing</i> .....                                | 53 |
| <i>Maintain Consistency of Objectives, Testing and Instruction</i> ..... | 54 |
| <i>Distributing Training over Time</i> .....                             | 55 |
| <i>Cooperation Among Students in Learning</i> .....                      | 56 |
| <i>Memorization Aids</i> .....   | 57 |
| <b>Acknowledgements</b> .....  | 58 |
| <b>Information for Obtaining Documents</b> .....                         | 59 |
| <b>Ordering Additional Copies and Providing Comments</b> .....           | 61 |

<sup>a</sup> These items have useful examples shown on the facing page.

# INTRODUCTION

William E. Montague  
Senior Scientist  
Training Technology Department  
Navy Personnel Research and Development Center

Expanding the Navy puts pressure on the training system to be more efficient and effective. More personnel are needed to run ships and fewer are available to train. New high-technology weapon systems require new training courses; the number of courses taught has nearly doubled in a decade. This poses a dilemma: Fleet expansion requires more personnel, student load increases, more courses are required and they need more instructors and training managers.

Making the best use of resources possible and making the training system more productive are obvious management goals. Can we do more with less? Can we find ways to operate Navy schools with fewer people while maintaining or increasing training quality? Can we aid instructors to enable them to teach more students as well, or better than they do now? Can surrogate instructors be developed and used to help instructors train more students? Can more training be done on ships, or on-station where knowledgeable personnel may be available to teach? Overall, can the productivity of Navy training increase to keep pace with demands put on it?

I am optimistic that affirmative answers can be made to those questions by continuing to apply instructional technology. The Military Services have been developing and applying instructional technology for many years. It is an evolutionary process. To continue to make progress, further development of the procedures is needed. That requires substantial resources. Personnel need to learn better ways of providing instruction. To become more efficient, the training system needs an infusion of technology based on knowledge of which technologies are effective, substantial management planning, and funding. Normally, such changes take years. This book is an attempt to help aid the process. It provides important, comprehensible information about the research bases for effective instructional practices for those running Navy training. The information can serve as a reminder and guide to implement improvements within the constraints of current training situations. It also provides information to assist with longer-term planning for training improvement.

The book is in keeping with policy established by the Chief of Naval Operations for promoting excellence in training, and with efforts by the Chief of Naval Education and Training to implement this policy by sponsoring efforts to improve Navy schooling, a program for developing 'model' schools, improved training for trainers, and training managers. It provides information distilled from research and practice specifically geared to education and training in Navy schools.

The objective is to provide Navy personnel involved with training with the best evidence regarding factors that make instruction effective. They can apply this information to improve the quality and productivity of Navy education and training. Sponsorship and resources for this effort were provided by the Chief of Naval Operations (OP-01). A group of expert advisors was enlisted to assist in selecting the entries to be useful and important for Navy training. Some of these advisors had been involved in analyzing and synthesizing research evidence, and others were involved in administering and managing Navy training.

We examined how training in the Navy is accomplished and identified three broad groups of users who play different roles in the training system. We examined policies and practices in training in order to identify the constraints under which the groups work. Then, we collected and reviewed the research literature to identify material relevant for the groups within these constraints. Whenever possible, we included research findings by military researchers. We included only those entries that research evidence and expert opinion suggested were stable and consistent. The difficult job was to translate the research findings into clear and comprehensible statements that we think can be used by users to guide their practices.

The Navy (as well as the other Services) has been sensitive to the difficulties involved in identifying appropriate content to be taught, in curriculum design, in writing instruction, in training instructors and in the control needed when purchasing courses from contractors. Instruc-

Fig 1  
tional technology was adopted on a broad scale to assist. System development procedures developed during and after World War II were gradually adapted for making the curriculum development process efficient and effective. The procedures were derived, as much as possible, from demonstrations of what works. However, the bases for the procedures are seldom explained and considerable competence is needed to use them. Development of this competence can be aided by examining the research evidence.

➤ This book provides some of the most up-to-date, reference information for the three broad classes of personnel that run Navy schools. There are *Training Executives* (Commanding Officers, Executive Officers, Training Officers, Training Petty Officers, etc.) who manage, administer, and supervise the training enterprise at various levels. *Instructors*, who are mostly military personnel on job-rotational assignments, are briefly trained to be teachers, and are assigned as instructors for relatively short periods. *Training Specialists* are a third group, about half are civilians, and they provide professional advice and assistance to the other groups, as well as assisting with evaluation, and course materials design and development. Training Executives, Instructors, and Training Specialists are often assigned those roles and responsibilities as part of their job rotation. They may have little formal training about instruction, instruction development, or management of instruction although the civilian training specialists are more likely to have formal training in education, teaching and relevant test and measurement methods.

By examining the roles, responsibilities and functions of the different user groups we constructed *A Plan for Achieving Excellence in Navy Training* (See the Tables on pp. 4-6.). The plan consists of actions (shown in the left column) that each group should focus on to help optimize the quality of Navy training. In each case, we examined the functions and roles of the group, and determined what they might do to improve instruction and student achievement. The research findings (shown in the right column) are paired with the actions and provide information that will assist users in carrying out those actions. Since the functions and responsibilities of the groups overlap, findings in one section may be of importance to those in other roles. Instructors may find items intended primarily for Training Executives useful for their purposes, and vice versa. Training Specialists may find all the items

useful.

The rest of the book is organized into sections presenting the research synopses. Each gives a short statement presenting the research findings of practical value for the user group. A comment section explains more about the findings and how one might implement conditions that should lead to similar results. References are included for readers who might be interested in the evidence supporting the finding or, in some cases describing detailed procedures for implementation. We did not try to provide complete documentation, rather we selected references that could point the way to further study by readers so interested. Most of these references can be obtained through a good library. In some cases, they may be available by mail from a reprint service. A section at the end of the book provides information about those services.

Each of the findings summarized in the different sections represents either a factual summary statement of the "weight" of research evidence, or a strong professional consensus where expert opinion is consistent, persuasive and stable. We selected the items carefully, from among many others that were judged less useful or more tentative in the light of research evidence or practice. We benefited from the example and the extensive work done in producing *What works: Research about teaching and learning*<sup>1</sup> by the staff and advisors of the Department of Education and actually used some of those items that were appropriate to the goals and constraints of Navy training. Mostly, new items were included because of the unique requirements of Navy education and training.

To make the document more usable and acceptable, we need constructive feedback from users and suggestions for additional entries. Therefore, this is a First Edition. During the next year or so we will collect comments and suggestions from groups of user personnel and correct and add to it. We will align the materials with Navy Instructions and Policy statements, and develop useful examples. When we complete that effort, as the Department of Education has done, we will publish a Second Edition.

Finally, we would like to thank the individuals who helped make this book possible. Their

<sup>1</sup> W. J. Bennett (1986). *What works: Research about teaching and learning*. Washington, D.C.: U. S. Department of Education.

names and affiliations are listed in the Acknowledgements section at the end of the book. Support was provided by the Chief of Naval Operations, and Ms. Jan Hart was our contact there. Dr. Ed Aiken, Dr. James McMichael provided enthusiastic support for the enterprise at NPRDC and my colleagues, Dr. John Ellis, Dr. Barbara McDonald, Dr. Jerry Vogt provided important information and assistance. Ms. Alice Crawford provided invaluable help with organization and editing. Mrs. Ruth Ireland helped make items that would communicate out of the academic jargon of researchers. LT Debra Gonzalez helped by reviewing a draft for comprehensibility. Mr. John Sole and Ms. Kathy Tinios provided valuable assistance in searching the literature and in organizing the book.

VADM Thunman provided guidance and adopted the project as part of his effort to make Navy Education and Training more effective. Dr. Joseph Haslett served as our principal advisor from CNET. From other Navy organizations, many people provided help. Mr. Robert King, Ms. V. Medley, Ms. D. Kalavoda, and Mr. C. Hartz, offered important constructive advice and information, as did Mr. M. Beech, and Mr. E. Chenette. Dr. H. Jellison labored hard with us to

help select usable material.

Primary advisors who assisted with judging the robustness of the research and in selection of items were as follows. Dr. Fred Knirk aided with the organization and writing. Dr. James Kulik lent his expertise in Meta-analysis. Dr. M. David Merrill provided valuable perspectives on instructional design. Dr. Jesse Orlansky provided guidance, constructive advice, and perspective on instructional technology. Dr. Ernst Rothkopf provided useful information about student learning. Dr. Thomas Sticht helped focus attention on student cognition. Finally, Dr. Herbert Walberg lent his enthusiasm, his expertise in research synthesis to the effort, and his experience in assisting the Department of Education prepare their book.

Although we are solely responsible for errors of style and content, the assistance of these individuals made this book possible. We hope that it will be read, enjoyed, and provide information useful for improving Navy education and training.

## A Plan for Achieving Excellence in Navy Training: For Executives

| Table 1.1  |  |
|--|--|
| Training Executives Can:   | Findings:  |
| <p>1. Become assertive instructional leaders by putting instructional excellence first.</p> <p>2. Focus programs on instructional goals and protect them from irrelevant demands.</p>  | <p><b>School Learning Environment:</b> Effective schools focus sharply on learners and learning.</p>   |
| <p>3. Demand high quality in training from staff, instructors, and students</p> <p>4. Develop and monitor in-service staff training.</p> <p>5. Encourage consensus on values and goals.</p> <p>6. Establish a system for evaluation and monitor it systematically.</p> | <p><b>Managing Instructors:</b> Effective training management policies improve instructor training, student performance, and training time management.</p> <p><b>Evaluating and Supervising Instructors:</b> Managers enhance instructor teaching skills by making frequent and systematic classroom observations and providing instructors with relevant and timely feedback that includes suggestions for correcting weaknesses.</p> <p><b>Managing Student Learning:</b> Performance-oriented leadership improves both formal (intentional) and informal (incidental) learning.</p> <p><b>Monitoring and Tailoring an Instructional System:</b> Instruction improves when managers monitor achievement indicators, detect when the value of any indicator moves into an unacceptable range, and then takes focused corrective action.</p>   |
| <p>7. Bring instructional technology and good practices to bear on instruction.</p>  | <p><b>Course Evaluation and Revision:</b> Tryouts during development of instructional materials help diagnose and repair inadequacies in the instruction.</p> <p><b>Imitating the Working Environment for Learning:</b> Students learn and retain knowledge and skills best when the learning environment incorporates the critical, functional features of the regular working environment.</p> <p><b>Maintaining Skills and Knowledge:</b> To maintain critical skills requires systematically planned and monitored on-the-job rehearsal and testing.</p> <p><b>Student-Instructor Ratio Tradeoffs:</b> Enlarging class size in moderately large basic courses has little, if any, effect on student learning while freeing some instructors for laboratory training, tutoring, or counseling.</p>  |
| <p>8. Promote a positive climate and overall atmosphere.</p>   | <p><b>Managing Informal Learning:</b> A focus on managing learning can improve the incidence and quality of informal learning in Navy environments.</p>  |
| <p>9. Plan and coordinate long-range changes in training to increase effectiveness and efficiency.</p> <p>10. Analyze and plan for use of technology to increase productivity.</p> <p>11. Consult with training specialists about training policy and practices.</p>   | <p><b>Planning Changes in Conducting Training:</b> Exploiting communications and computer technology can serve policy goals and meet training needs within resource constraints.</p> <p><b>Cost Effectiveness:</b> Consistent and credible evaluations of cost-effectiveness must justify any plans to substitute alternative training programs for those now in use.</p> <p><b>Structured Instruction:</b> Students can learn as well from structured instructional material and self-study as from conventional classroom procedures.</p> <p><b>Computer-based Instruction:</b> Students learn the same content as well or better from computer-based instruction as in a regular classroom situation, complete the lessons faster, and the course materials can be widely distributed and given at any time.</p> <p><b>Video Technologies for Instruction:</b> Video technologies can simulate world events, equipment, or tasks and can deliver interactive instruction to learners at formal schools and remote work sites.</p> <p><b>Training Devices for Task Simulation and Practice:</b> Simulators enable learners to acquire the knowledge they need to operate and repair devices, to practice at speed: not constrained by real time, and at a fraction of training cost using actual equipment.</p> <p><b>Distributed Instruction:</b> Students not at formal schools can interact with instructors through modern communications technology such as networked computers with or without television.</p> <p><b>Adopting Training Innovations:</b> Managers and training developers can effect the rate at which the schools and instructors adopt and use newly developed training materials and programs.</p> |

## A Plan for Achieving Excellence in Navy Training: For Instructors

Table 1.2

| Instructors Can:   | Findings:  |
|--|--|
| 1. Bring good practices to bear on training.   | <b>Rating Instructors:</b> Feedback from student ratings of instructors enables instructors to improve their performance.  |
| 2. Focus classroom activities on learning.   | <b>Instructor Classroom Role:</b> Student activities during learning are more important in determining what is learned than the instructor's presentation. Instructors aid student achievement by getting students to engage in activities that are likely to result in learning.<br><b>Instructor Classroom Leadership:</b> Effective instructor leadership in the classroom promotes effective student learning. |
| 3. Emphasize student learning and achievement.   | <b>Teaching Students How To Learn:</b> The way students study influences what and how much they learn. Students can learn effective study strategies.  |
| 4. Monitor student studying and adjust their activities to maximize their effort and progress.       | <b>Testing Student Learning:</b> Frequent, systematic testing and assessing student progress informs students about their learning and instructors and managers about strengths and weaknesses in student learning and the instruction.  |
| 5. Give corrective feedback regularly.   | <b>Giving Feedback to Students:</b> Students who receive constructive feedback about the accuracy and adequacy of their performance become more interested in the class and learn more.  |
| 6. Promote effective use of instructional time in learning.  | <b>Managing Class Time:</b> Students who spend as much time as possible actively engaged in learning learn more than do students who do not.   |
| 7. Learn and use teaching techniques that enhance student learning.                                  | <b>Cooperation in Learning:</b> Cooperating with other students in learning often improves learning.<br><b>Peer Teaching:</b> Peer "teachers" and their students receive higher grades on tests and develop more positive attitudes toward the courses with peer teaching.   |
| 8. Provide well-structured presentations and classroom activities.                                   | <b>Instructor Presentation Stimulates Learning:</b> Students perform best when their instructors inspire them to take an active role in their learning.  |
| 9. Arrange many and varied learning opportunities.   | <b>Practice:</b> Practicing lesson-related tasks promotes learning new skills.   |
| 10. Create a job-like instructional situation.   | <b>Promote Development of Mental Models:</b> When students are asked to act in accordance with a prescribed "model" of performance, they develop conceptual understanding that guides competent performance more effectively.  |
| 11. Emphasize hands-on, job-like performance tests.  |  |
| 12. Test and question students to evaluate their learning progress and maintain motivation to learn. | <b>Motivating Students:</b> Learning improves when students know how to set their own goals and how to achieve them.   |
| 13. Provide students with opportunities for individualized work.                                     | <b>Student Control of Learning:</b> Students' perception of who controls the key events in learning significantly affects their learning achievement.  |
| 14. Design out-of-class assignments to increase student achievement.                                 | <b>Out-of-class Assignments:</b> Student performance improves significantly when instructors regularly give out-of-class assignments, make sure they are completed, and give explicit feedback about the adequacy of the completed assignment.   |

## A Plan for Achieving Excellence in Navy Training: For Specialists

| Table 1.3   |  |
|---|--|
| Training Specialists Can:   | Findings:  |
| <p>1. <i>Become assertive instructional leaders by emphasizing factors that bring about excellence.</i></p> <p>2. <i>Learn and apply scientific bases for training excellence.</i></p>                                      | <p><b>Systematic Approaches to Training Design:</b> Systematic training design models provide tools for planning, organizing, and managing instructional development and limit the content to that clearly needed.</p> <p><b>Training Objectives:</b> Training objectives that reflect training requirements directly are easy to see and test.</p> <p><b>Writing Text Materials:</b> Enhancement of text in books or manuals through orientation, summaries, examples, and diagrams can aid student comprehension and learning.</p> <p><b>Readability of Training Materials:</b> Readability scores indicate approximately how much difficulty students will have in reading or listening to training materials.</p> <p><b>Learning Built on Knowledge:</b> Students learn best when instruction is adapted to their existing knowledge and background.</p> <p><b>Using Examples and Nonexamples:</b> Providing students with representative good examples and contrasting them with bad examples teaches them desired knowledge and skills.</p> <p><b>Motivating Student Learning:</b> When instruction gets students' attention, is perceived as relevant and as having attainable goals, and provides frequent testing and explanatory feedback, students work hard, achieve well and enjoy learning.</p> <p><b>Designing Effective Illustrations and Graphs:</b> Diagrams, graphs, photographs, and illustrations can improve learning.</p> <p>See Findings under numbers 9,10,11 in Table 1.2.</p> |
| <p>3. <i>Expect high quality and productivity from staff, instructors, and students.</i></p> <p>4. <i>Implement and monitor in-service staff training.</i></p>  | <p>See Findings under numbers 3-6 in Table 1.1.</p>  |
| <p>5. <i>Monitor and evaluate instructors and instruction.</i></p>  | <p><b>Formative Evaluation of Instruction:</b> Tryouts of instruction determine where representative students have difficulty in understanding, where testing is needed, and instructional efficacy.</p>   |
| <p>6. <i>Promote interaction among instructors.</i></p> <p>7. <i>Protect instruction from irrelevant demands.</i></p> <p>8. <i>Develop well structured, work-like training environment to support student learning.</i></p> | <p>See Findings under numbers 3-6 in Table 1.1.</p> <p><b>Using Simulation for Training:</b> Effective simulation provides systematic practice, feedback about errors, depicts how a device or system works but may violate physical and temporal fidelity. See Findings under numbers 10, 11 in Table 1.2.</p>  |
| <p>9. <i>Adjust training to goals and to learners through detailed evaluation of performance.</i></p>   | <p><b>Criterion Referenced Testing:</b> Testing needs to be geared closely to the goals of the training program.</p>   |
| <p>10. <i>Assist instructors in providing feedback to students.</i></p>   | <p>See Findings under numbers 3, 4, 5 in Table 1.2</p>   |
| <p>11. <i>Monitor development and empirical evaluation of training technologies.</i></p>  | <p><b>Maintaining Consistency of Objectives, Testing and Instruction:</b> Course effectiveness and efficiency depends on the consistency between training requirements, implied task requirements, objectives, task statements, and how instruction is presented.</p> <p>See Findings under numbers 4, 9-11 in Table 1.1, number 10-11 in Table 1.2.</p>   |
| <p>12. <i>Analyze and propose improvements in training effectiveness and efficiency.</i></p>  | <p><b>Distributing Training Over Time:</b> Spacing learning or practice over several sessions separated by other activities makes training more effective than equal amounts of massed or concentrated practice.</p> <p><b>Cooperation Among Students in Learning:</b> Students who help each other and work together learn more than those who learn alone.</p> <p><b>Memorization Aids:</b> Mnemonic devices or coding systems help students recall important information when needed.</p>   |
| <p>13. <i>Provide input to higher management regarding training policy.</i></p>   | <p>See Findings under number 9-11 in Table 1.1.</p>  |

# for Training Executives

---

## Training Executives Can:

- 
- Become assertive instructional leaders by putting instructional excellence first.
  - Focus programs on instructional goals and protect them from irrelevant demands.
  - Demand high quality in training from staff, instructors, and students.
  - Develop and monitor in-service staff training.
  - Encourage consensus on values and goals.
  - Establish a system for evaluation and monitor it systematically.
  - Bring instructional technology and good practices to bear on instruction.
  - Promote a positive climate and overall atmosphere.
  - Plan and coordinate long-range changes in training to increase effectiveness and efficiency.
  - Analyze and plan for use of technology to increase productivity.
  - Consult with training specialists about training policy and practices.
-

## School Learning Environment

---

**Finding:** Effective schools focus sharply on learners and learning.

**Comments:** Training executives and instructors can increase the quality of instruction by implementing policies that encourage effective instruction. They emphasize frequent testing, especially testing of job-like performance, critical job skills, and safety practices. They encourage effective time management to reduce or eliminate time spent on activities irrelevant to training objectives and to maximize interaction between students and instructors, learning materials, and learning tasks. They recognize that students do not learn simply as a result of listening to lectures.

Students must be psychologically and physically comfortable. Long lectures with long periods of sitting and without opportunities for practice inhibit effective learning.

Educational managers need to work with instructors, students, and the operational community to develop and establish a positive learning environment that will become a lasting part of the school's tradition.

When instructors collaborate in developing goals, sharing advice about teaching, and emphasizing student achievement, instruction as well as students' performance improves.

**References:** Corcoran, T. (1985, May). Effective secondary schools. In R. Kyle (Ed.), *Reaching for excellence: An effective schools sourcebook* (pp. 71-97). Washington, DC: U.S. Government Printing Office.

Doyle, W. (1985, May). Effective secondary school practices. In R. Kyle (Ed.), *Reaching for excellence: An effective schools sourcebook* (pp. 55-70). Washington, DC: U.S. Government Printing Office.

Edmonds, R. (1982). Programs of school improvement. *Educational Leadership*, 40(3), 4-11.

Glidewell, J., Tucker, S., Todt, M., & Cox, S. (1983). Professional support systems: The teaching profession. In A. Nadler, J. Fisher and B. DePaulo (Eds.), *New directions in helping* (pp. 189-210). New York: Academic Press.

Little, J. W. (1982) Norms of collegiality and experimentation. *American Educational Research Journal*, 19(3), 325-340.

Walberg, H.J., & Anderson, G.J. (1968). Classroom climate and individual learning. *Journal of Educational Psychology*, 59(6), 414-419.

## Managing Instructors

---

**Finding:** Effective training management policies improve instructor training, student performance, and training time management.

**Comments:** Successful training executives have an accurate conception of the important factors determining effective instruction. They keep this conception in mind as they interact with personnel and allocate funds. With instructional improvement as a constant theme, they scrutinize existing practices to assure that instructor activities and procedures contribute to the quality of the instructional program. They make sure instructors are trained and participate actively in this process. Effective managers, for example, provide instructors with opportunities to improve their teaching and classroom management skills. They minimize instructors' administrative chores and teaching interruptions, monitor teaching performance, and provide constructive suggestions for improvement.

Effective managers actively support learning. They create an orderly environment, verify that instructors have all the necessary instructional materials and assistance they need, work to raise instructor morale, and create a climate of achievement by encouraging new ideas and involving instructors in policy formation.

- References:** Bird, T., & Little, J. W. (1985). *Instructional leadership in eight secondary schools* (Final Report to the U.S. Department of Education, National Institute of Education). Boulder, CO: Center for Action. (ERIC Document No. ED 263 694)
- Camine, D. R., Gersten, R., & Green, S. (1982, December). The Principal as an instructional leader: A second look. *Educational Leadership*, 40(3), 47-50.
- Corcoran, T. (1985, May). Effective secondary schools. In R. Kyle (Ed.), *Reaching for excellence: An effective schools sourcebook* (pp. 82-85). Washington, DC: U.S. Government Printing Office.
- Morris, V.C., Crowson, R., Hurwitz, E., & Porter-Gehrie, C. (1986). *Principals in action: The reality of managing schools*. Columbus, OH: Charles E. Merrill Publishing Co. Cited in *What Works: Research about Teaching and Learning*, (2nd ed., p. 64). Washington, DC: U. S. Department of Education.
- Skinner, B. F. (1984). The shame of American education. *American Psychologist*, 39(9), 947-954.

## Evaluating and Supervising Instructors

---

**Finding:** Managers enhance instructor teaching skills by making frequent and systematic classroom observations and providing instructors with relevant and timely feedback that includes suggestions for correcting weaknesses.

**Comments:** Effective managers ensure that the instructors know the subject matter and can communicate it. The teaching skills of instructors who know their subject matter can usually be improved to a higher level. Teaching is a skilled activity that takes time and the proper conditions to develop. To develop a *skilled teacher* may take years. The most effective way to develop instructor teaching skills is to provide adequate opportunities to teach under supervised conditions where the observer may analyze inadequacies and provide constructive feedback.

Supervision that strengthens instruction and improves instructor morale has these elements:

- The supervisor and the on-the-job instructor agree on the specific skills and practices that characterize effective teaching.
- The supervisor observes the instructor frequently to verify that the instructor uses these skills and practices.
- The supervisor and the instructor meet to discuss the supervisor's observations.
- The supervisor and instructor agree on areas for improvement.
- The supervisor and instructor jointly develop a specific plan for improvement.

Managers can further improve instruction by intelligently using student ratings as a basis for corrective feedback. Ratings during a course rather than at the end only provide the opportunity to modify teaching with the same groups of students. Fellow instructors or consultants can help individual instructors plan how to improve their teaching based on student feedback.

**References:** Cohen, P. A. (1981). Effectiveness of student-rating feedback for improving college instruction: A meta-analysis of findings. *Research in Higher Education*, 13, 321-341.

Fielding, G.D., & Schalock, H.D. (1985). *Promoting the professional development of teachers and administrators*. Eugene, OR: ERIC Clearinghouse on Educational Management.

Natriello, G. (1984). Teacher's perceptions of the frequency of evaluation and assessments of their effort and effectiveness. *American Educational Research Journal*, 21(3), 579-595.

Natriello, G., & Dombusch, S.M. (1981). Pitfalls in the evaluation of teachers by principals. *Administrator's notebook*, 29(6), 1-4.

Skinner, B.G. (1984). The shame of American education. *American Psychologist*, 39(9), 947-954.

Wise, A. E. (1984). *Teacher evaluation: A study of effective practices*. Santa Monica, CA: Rand Corporation.

## Managing Student Learning

---

**Finding:** Performance-oriented leadership improves both formal (intentional) and informal (incidental) learning.

**Comments:** Managers and instructors are primarily concerned with formal learning developed using systematic procedures designed to promote effective training. However, promoting informal or incidental learning can also further formal instruction. To manage learning effectively both in and out of the classroom, training managers should:

- Assert convictions and philosophies with regard to the importance of learning by each individual.
- Specify the roles of officers, chiefs, and petty officers in managing learning and training.
- Specify the role of individual sailors in managing of their learning.
- Personally observe and evaluate the learning environment of schools and their surroundings including:
  - Who is doing what, when, where, and why and how these actions match their stated philosophy and objectives?
  - How does the physical learning environment affect learning?
  - What is happening in the school that should not be happening?

Sailors learn a lot about informal Navy life and their jobs outside of the formal presentations at school. Instructors provide some of this informal training as role models whose incidental behavior the learners observe and adopt. Other students also significantly affect what students learn.

**References:** Hill, H. & Sticht, T. (1980, September). *Perspectives on battalion training management*. (Final Report for USAREUR Field Unit). Alexandria, VA: Human Research Organization.

Kern, R. (1986). Modeling information processing in the context of job training and work performance. In T. Sticht, F. Chang, & S. Wood (Eds.), *Cognitive science and human resources management (Advances in reading/language research, vol 4)*. Greenwich, CT: JAI Press.

Morgan, M., Hall, D.T., & Martier, A. (1979). Career development strategies in industry: Where are we and where should we be? *Personnel*, 56 (2), 13-31.

## Monitoring and Tailoring an Instructional System

---

**Finding:** Instruction improves when managers monitor achievement indicators, detect when the value of any indicator moves into an unacceptable range, and then take focused corrective action (tailoring).

**Comment:** Monitoring and tailoring of instructional systems resembles controlling physical systems such as heating or cooling systems. However, the relevant indicators in training systems are less precise than those in physical systems. They must be determined by examining the goals of the schools, the management practices, and objective information about students and instructors.

Training executives can monitor direct and indirect student performance indicators to establish priorities for improving the system. Direct indicators include student attrition and the rate students are "set back" to repeat lessons, and comprehensive and performance test scores. Indirect indicators include student-instructor ratios and background variables. This monitoring requires access to longitudinal records and considerable information processing. With a computer-based information system, managers can identify indicators with values that are in an unacceptable range. Over time, monitoring will reveal whether the quality of instruction is being improved.

Focused corrective action or tailoring requires a deployable resource to respond to the indicators. For example, an instructional supervisor or curriculum standards office representative might visit a classroom or school to confirm (or refute) that a problem exists, diagnose the situation, and propose corrective action.

The monitoring and tailoring approach assumes that fine tuning the instructional system can improve the system significantly. The system may require fundamental changes due to changes in technology, resources, or society.

**References:** Cooley, W. W. (1983, June/July). Improving the performance of an educational system. *Educational Researcher*, 12 (6), 4-12.

Cooley, W.W., & Lohnes, P.R. (1976). *Evaluation research in education: Theory, principles, and practice*. New York: John Wiley & Sons.

Walberg, H. J. (1984, May). Improving the productivity of America's schools. *Educational Leadership*, 41(8), 19-36.

## Course Evaluation and Revision

---

**Finding:** Tryouts during development of instructional materials help diagnose and repair inadequacies in the instruction.

**Comments:** Designing instruction involves making many decisions such as how to present information to the students, judging student comprehension, and knowing when they have learned enough to move on to new material. The design and development process involves numerous subjective opinions, and quality of the instruction depends on the skill and knowledge of the developers. The material may only approximate the optimal product. Evaluating and revising the instruction to improve it is an important part of the process. The instructional developer accomplishes this by taking segments of material to a sample of the target students for tryout. Ideally, one developer goes through the material with one student at a time. During tryouts, students might be asked about the quantity and quality of examples in the instruction, the adequacy of opportunities provided for practice, the suitability of media selected for a given training domain, the compatibility of the reading grade level of the materials and the student audience, and the time required for the student to complete the instruction compared to allotted training time. The developer then revises the materials to address problems uncovered in tryout and conducts another tryout with different students.

Training development rarely includes this evaluation-revision cycle. Tryouts of materials in nearly final form are more common. At this late stage, however, it is difficult to diagnose instructional problems unless gross failure make them apparent. The lack of evaluation during development makes revision of instruction a major undertaking.

Managers who plan and allocate adequate resources for early evaluation make revision and the instruction more effective.

**References:** Cronbach, L. J. (1963). Course improvement through evaluation. *Teacher College Record*, 64, 672-683.

Ellis, J.A., Knirk, F.G., Taylor, B.E., & McDonald, B.A. (1987). *The Course Evaluation System*. (NPRDC TR 87-19.), San Diego, CA: Navy Personnel Research and Development Center.

Markle, S. M. (1967) Empirical testing of programs. In P. C. Lange (Ed.), *Programmed instruction: The sixty-sixth yearbook of the national study of education, Part II*. Chicago: University of Chicago Press.

Merrill, M. D., Reigeluth, C. M., & Faust, G. W. (1979). The instructional quality profile: A curriculum evaluation and design tool. In H. F. O'Neil Jr (Ed), *Procedures for instructional systems development* (pp. 165-202). New York: NY, Academic Press.

Montague, W. E., Ellis, J. A., & Wulfeck II, W. H. (1983). Instructional quality inventory: A formative evaluation tool for instructional development. *Performance and Instruction Journal*, 22(5), 11-14.

## Imitating the Working Environment for Learning

---

**Finding:** Students learn and retain knowledge and skills best when the learning environment incorporates the critical, functional features of the working environment.

**Comments:** For maximum transfer from the training to a work environment, the learning environment should include the context, tasks, procedures, and materials of the job. Thus, training situations should relate to specific job situations as well as to the knowledge students already have. The training situation should involve the same operations, the same tools, and the same machines (or their functional equivalents) as the actual job.

New knowledge is built on the foundations of old knowledge. The training situation should relate the students' existing knowledge to facilitate learning and correct any incomplete or incorrect understanding of how and why things work. Students with adequate knowledge can use it as a bridge to understand new knowledge.

Another important aspect of imitating the working environment is to train students to the level their work supervisors expect. If a graduate will be heavily supervised on the job, then the training program should not expend the time and effort to graduate students with a level of competence which does not require supervision; that is, to a level where they may resent "someone looking over their shoulder."

Minimal on-the-job supervision requires higher levels of classroom training. If training and working environments differ in their skill expectations and closeness of supervision, training may have to be tailored for the expected assignment. Effective training managers should solicit feedback about graduates to detect problems in mismatches between levels of training and expectancies.

**References:** Prosser, C. A., & Quigley, T. H. (1949). *Vocational education in a democracy*. Chicago, IL: American Technical Society.

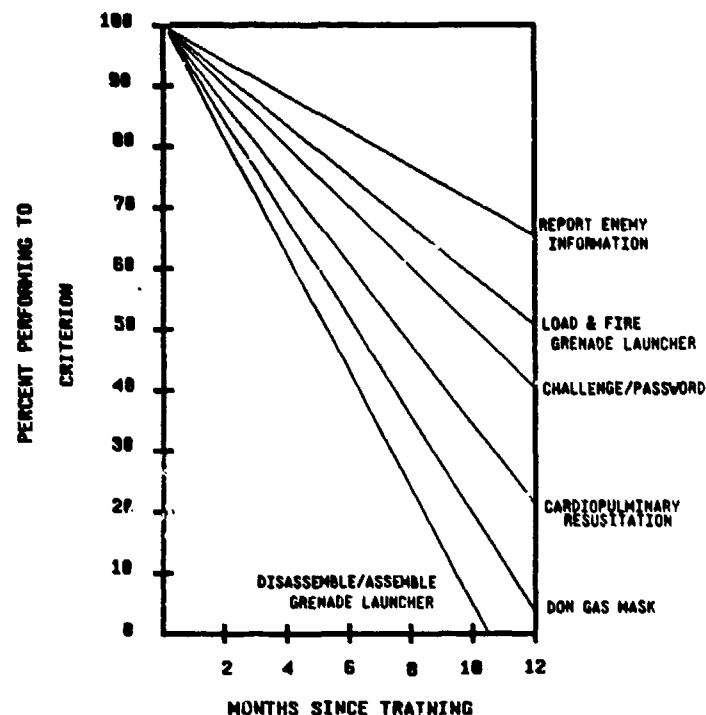
Sticht, T. (1987). *Functional context education workshop resource notebook*. San Diego, CA: Applied Behavior and Cognitive Sciences, Inc.

Sticht, T. G., Armstrong, W. B., Hickey, D. T., & Caylor, J. S. (1987). *Cast off youth: Policy and training methods from the military experience*. New York: Praeger.

Walberg, H. J. (1984, May). Improving the productivity of America's schools. *Educational Leadership*, 41(8), 19-36.

## Skill Deterioration

Without systematic refresher training, performance of procedural skills declines rapidly after training.



The figure depicts the decline in the number of soldiers able to perform basic soldiering tasks adequately after training. The rate of skill loss differs for different tasks perhaps due to the varying number of steps in each procedure. In any case, the decline suggests the need for providing systematic practice to maintain skills.

**References:** Hagman, J. D. & Rose, A. M. (1983). Retention of military skills: A review. *Human Factors*, 25(2), 199-213.

Shields, J. L., Goldner, S. L., & Dressel, J. D. (1979, September). *Retention of basic soldiering skills* (Research Report 1225). Alexandria, VA: U. S. Army Research Institute for the Behavioral and Social Sciences.

## Maintaining Skills and Knowledge

**Finding:** To maintain critical skills requires systematically planned and monitored on-the-job rehearsal and testing.

**Comments:** Everyone loses trained skills and knowledge during extended periods without specific exercise or practice. Extended periods of nonuse are common in Navy job assignments.

Normally, Navy schools only provide the amount of training students need for minimal competence. Proficiency is supposed to be developed on the job. Considerable evidence shows that attention to rehearsal of rarely used skills is often lacking. For example, Army researchers found that few soldiers who performed basic soldiering tasks adequately after training could perform them adequately after a year in the field. See the figure on the previous page. Apparently, they had not performed or rehearsed most of the skills during the year. Analysis of conditions in the Navy also reveals occupations in which sailors do not practice new skills for long periods. Such lapses promote losses, not improvement, of skill and knowledge. Thus, systematic management of skill maintenance is needed to develop high competence.

There is no way to make accurate, quantitative predictions about the rate of skill loss, how fast relearning occurs, or how often retraining should occur. What is known is that initial learning during training must include the maximum amount of practice possible and that successive retraining or exercise sessions are needed at spaced intervals. Time management during initial training must ensure that time allotted is used for practicing the skill and not for irrelevant activities such as waiting for equipment or watching others perform.

One suggestion is to base the spacing of refresher practice sessions for novices on how often journeymen perform the skill or task. For example, if journeymen perform a task monthly, rehearsal spacing of about a month might be advisable for novices.

In cases where rehearsals are difficult or too costly to arrange, more than minimal learning should be provided during the original course. The main point is that planning and scheduling the rehearsal of critical skills is mandatory.

**References:** Bahrick, H. P. (1979). Maintenance of knowledge: Questions about memory we forgot to ask. *Journal of Experimental Psychology*, 108(3), 296-308.

Farr, M. J. (1986). *The long-term retention of knowledge and skills: A cognitive and instructional perspective* (IDA Memorandum Report MR-205). Alexandria, VA: Institute for Defense Analyses.

Hagman, J. D., & Rose, A. M. (1983). Retention of military skills: A review. *Human Factors*, 25(2), 199-213.

Wetzel, S. K., & Montague, W. E. (1983, March). *Conditions influencing skill deterioration: A survey of three Navy sonar communities* (NPRDC SR 83-18). San Diego, CA: Navy Personnel Research and Development Center.

## Student-Instructor Ratio Tradeoffs

---

**Finding:** Enlarging class size in moderately large basic courses has little, if any, effect on student learning while freeing some instructors for laboratory training, tutoring, or counseling.

**Comments:** Small student-instructor ratios tend to promote frequent interactions between students, instructors, and materials. Students in small classes have more interest in learning, achieve more, have a somewhat better self-image, and have a better quality of interaction between student and teacher than do students in large classes. Teachers in small classes may have higher morale. In colleges, where classes are fairly large, both instructors and students prefer smaller classes, but larger classes do not affect student academic achievement. When class size is more than about a dozen or so students, there are fewer opportunities for students to participate in discussions. In lecture presentations, class size makes hardly any difference because students are already passive and interactions are minimal. Therefore, for basic "academic" training courses, class size--unless below 10 or so students--does not affect student learning until it gets large enough to prevent students from seeing or hearing the instruction.

Changing instructor-student ratios enables managers to manage their instructor resources in ways that can improve student learning. Instructors now relieved from presenting duplicate or repetitive courses can prepare other presentations, interact with students individually or in small groups, conduct laboratory exercises, or evaluate and revise existing courses.

**References:** Bozzomo, Lawrence L. (1978). Does Class Size Matter? *National Elementary Principal*, 57(2), 78-81.

Glass, G. V., Cahen, L. S., Smith, M. L., & Filby, N. N. (1982). *School class size: Research and policy*. Beverly Hills, CA: Sage.

Williams, D.D., Cook, P.F., Quinn, B., & Jensen, R.P. (1985). University class size: Is smaller better? *Research in Higher Education*, 23(3), 307-18.

## Managing Informal Learning

---

**Finding:** A focus on managing learning can improve the incidence and quality of informal learning in Navy environments.

**Comments:** Individuals obtain much of their knowledge and learn some skills outside of formal school settings. Some informal learning such as learning poor work habits from the examples of others is negative. Commanders and managers can influence informal learning of sailors by:

- Applying environmental designs for learning; for example placing posters with critical information in mess halls, hallways, and other places where sailors spend time. Messages should be designed for ease of learning, motivation, and creating awareness.
- Promoting learning requirements for off-time during watch standing, placing learning materials in job/duty sites, requiring reading of job and training materials when on-duty during slack periods, and verifying that the assignments are done.
- Encouraging all personnel including individual sailors to think; dedicating "read and think" time during duty hours for personnel to think about what they do and how to do it better.

**References:** Hall, D. T., & Fukami, C. V. (1979). Organization design and adult learning. *Research in Organizational Behavior*, 2, 125-167.

Hill, H., & Sticht, T. (1980, September). *Perspectives on battalion training management* (Final report, USAREUR Field Unit). Alexandria, VA: Human Resources Research Organization.

Kern, R. (1986). Modeling information processing in the context of job training and work performance. In T. Sticht, F. Chang, & S. Wood (Eds.), *Cognitive science and human resources management (advances in reading/language research, Vol 4)*. Greenwich, CT: JAI Press.

Morgan, M., Hall, D. T., & Martier, A. (1979). Career development strategies in industry: Where are we and where should we be? *Personnel*, 56 (2), 13-31.

Rogoff, B., & Lave, J. (1984). *Everyday cognition: Its development in social context*. Cambridge, MA: Harvard University Press.

## Planning Changes in Conducting Training

**Finding:** Exploiting communications and computer technology can serve policy goals and meet training needs within resource constraints.

**Comments:** Many revolutionary changes in communications and computer technologies can be used for instructional purposes with, or sometimes, instead of teachers, books and manuals, and chalkboards. Various technologies can deliver training that can be as effective or even more effective than current methods. To exploit the advantages of these technologies requires good analysis and planning. The capabilities and effectiveness benefits must be mapped against needs and the current costs of training including training time. Funding must be found for research and development and evaluation of new systems designed to make training more effective and efficient.

The rapid development of new technologies seems to point to the inevitability of significant changes in the way training is accomplished. At the same time, the potential costs of these changes requires caution and a practical outlook. Claims of large benefits in effectiveness must be substantiated by concrete, conclusive empirical evidence. Decades of research reveal that improvements in instructional achievement are usually not due to the communications-computer technology but to redesign of the content. Permitting each student to learn at his own pace, with or without computers, is an important source of the gain.

New technology may make possible the delivery of novel forms of instruction where, when, and in ways heretofore impossible, as well as delivery of fairly standard instructional matter to students not assigned to schoolhouses. In any case, large scale implementation of training technologies that substantially change the organization and presentation of training should be undertaken only after formal study of its cost effectiveness.

The following pages discuss some of the technologies briefly.

- References:** Bergman, R. E. (1981). Technology and training: The shape of tomorrow's seminar. *Performance and Instruction*, 20(9), 4-12.
- Kearsley, G. (1984). *Training and technology: A handbook for HRD professionals*. Reading, MA: Addison-Wesley Publishing Co.
- Knapp, M. L., & Orlansky, I. (1983, November). *A cost element structure for defense training* (IDA Paper P-1709). Alexandria, VA: Institute for Defense Analysis.
- Orlansky, J., & Suring, J. (1981, Second Quarter). Computer-based instruction for military training. *Defense Management Journal*, 46-54.
- Walberg, H. J. (1987, April). Curricular efficiency can be attained. *National Association of Secondary School Principals Bulletin*, 71 (498), 15-21.

## Cost Effectiveness

---

**Finding:** Consistent and credible evaluations of cost-effectiveness must justify any plans to substitute alternative training programs for those now in use.

**Comments:** Because of the rapid decline in the cost of computer-based and communications technologies during the last decade, considering their use in the delivery of instruction seems attractive. But, as long as other aspects of the instructional system remain unchanged, introducing new technology merely increases the already high cost of training. To offset or justify the cost of the technology, benefits should be demonstrable. For example, instructor productivity or the number of students graduated in a time period should increase, student performance should improve substantially, or administrative burdens over the life of the system should be reduced. Such changes require good management planning as well as changes to the instructional program.

The decision to implement a particular training program, course or device or to change an existing one rests upon identifying all the costs of all the alternatives such as the cost of research and development, all personnel costs in development, the development as well as delivery costs of all versions of the equipment, the cost of running the implementation for the life of the system including operation and maintenance. Then, if the training systems demonstrate about the same effectiveness, the one that costs less might be preferred. Substantial, demonstrated differences in training effectiveness might justify choosing a more costly system. Both cost and effectiveness must be considered explicitly in analysis conducted to enable selection among alternative training programs, courses, or devices to fulfill a specific need.

**References:** Knapp, M. I., & Orlansky, J. (1983, November). *A cost element structure for defense training* (IDA Paper P-1709). Alexandria, VA: Institute for Defense Analysis.

Orlansky, J., & String, J. (1981, Second Quarter). Computer-based instruction in military training. *Defense Management Journal*, 18(2), 46-54.

Niemiec, R. P., & Walberg, H. J. (1987). Comparative effects of computer-assisted instruction: A synthesis of reviews. *Journal of Educational Computing Research*, 3, 19-37.

## Structuring Instruction

---

**Finding:** Students can learn as well from structured instructional material and self-study as from conventional classroom procedures.

**Comments:** Dividing instructional materials into learnable segments, determining their presentation order, and requiring students to pass tests to demonstrate their comprehension before allowing them to go to new material is structuring instruction. It works at least as well as conventional methods for teaching knowledge. Structured instructional materials also provide students with an opportunity for self-paced study, which can save considerable training time, and can be distributed to remote locations as alternatives to lectures.

Sequences of instruction are designed to require an active response from students before new information is presented. Students get immediate feedback telling them whether the response was correct. Sometimes branching enables students to omit material they already know. If students make errors, they may be required to study segments again. This method of organizing and presenting information can be used to deliver instruction on various media such as computers, workbooks, or lectures. Many computer-aided instruction (CAI) programs are examples of structured instruction; others use simulation or gaming techniques.

Students who progress through the materials at their own rate complete the materials in about one-third less time than do students who attend conventional courses.

Students prefer having an instructor present the instruction, partly because they have learned to learn in a lecture situation. They prefer sitting in a classroom with a human being who can listen and respond rather than sitting in a media carrel with a computer terminal or a slide-tape program. Student attitudes toward the content, however, do not vary much in either situation.

**References:** Fishburne, R. P., & Mims, D. M. (1975, March). *Formative evaluation of an experimental BE/E program* (Research Branch Report 9-75). Naval Air Station Memphis, Millington, TN: Chief of Naval Technical Training.

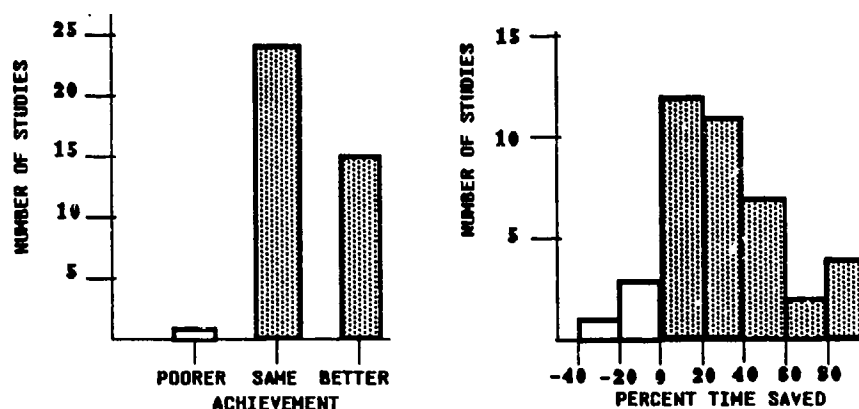
Kulik, C. C., Schwalb, B. J., & Kulik, J. A. (1982). Programmed instruction in secondary education: A meta-analysis of evaluation findings. *Journal of Educational Research*, 75(3), 133-138.

Orlansky, J., & String, J. (1981, Second Quarter). Computer-based instruction for military training. *Defense Management Journal*, 46-54.

Walberg, H. J. (1984, May). Improving the productivity of America's schools. *Educational Leadership*, 41(8), 19-36.

## Effectiveness of Computer-Based Training

**In military training courses, computer-based instruction has been found to be at least as effective as standard lecture courses and students complete them substantially faster.**



The figure above provides a graphic summary of a review of 40 research studies comparing the effectiveness of computer-based and standard training in the Navy, Army, and Air Force. Fifteen studies reported higher achievement for students in computer-based courses, and 36 reported that students in computer-based courses finished in less time.

**Reference:** Orlansky, J. & String, J. (1979, April). *Cost-effectiveness of computer-based instruction in military training* (TDA Paper P-1375). Alexandria, VA: Institute for Defense Analyses. (AD-A073 400; ERIC Document No. ED 195 227)

## Computer-Based Instruction

**Finding:** Students learn the same content as well or better from computer-based instruction as in a regular classroom situation, complete the lessons faster, and the course materials can be widely distributed and given at any time.

**Comments:** A review of nearly 200 studies comparing computer-based instruction (CBI) with conventional elementary, secondary, and college classroom instruction found that computer-based instruction raised student achievement significantly, gave students a better appreciation of technology, improved student attitudes toward schools and teaching, and helped teachers manage instructional time. A review of 40 studies comparing standard military classroom instruction with computer-based instruction found that CBI student performance achievement improved in 15 cases, remained the same in 24 cases and was poorer in 1. In addition, students completed the CBI lessons in about 30 percent less time than that allotted for the conventional courses. This finding may be important where students are paid and training time needs to be as brief as possible. This evidence tends to verify the suitability of computer-based training in the military.

These effectiveness and efficiency gains did not result simply from using computers in instruction but from imposing a systems approach for design on the courses and allowing students to progress at their own learning rates. In military courses where course materials and tests already address training objectives derived from job-task analysis, gains in student performance would not be expected, although time savings compared with the length of conventional courses would be expected. Therefore, careful planning is necessary before deciding to use computer-based instruction in each situation and, only if cost-effectiveness evaluation justifies its use, should it be adopted.

- References:** Hassellbring, T. (1986). Research on the effectiveness of CBI: A review. *International Review of Education*, 32, 313-324.
- Kulik, J. A., & Kulik, C. C. (1987). Review of recent research literature on computer-based instruction. *Contemporary Educational Psychology*, 12(5), 222-230.
- Montague, W. E., & Wulfeck II, W. H. (1984). Computer-based instruction: Will it improve instructional quality? *Training Technology Journal*, 1(2), 4-19. Also, NPRDC TR 84-54, San Diego, CA: Navy Personnel Research and Development Center. (AD-A146 269)
- Niemiec, R. P., & Walberg, H. J. (1987). Comparative effects of computer-assisted instruction: A synthesis of reviews. *Journal of Educational Computing Research*, 3, 19-37.
- Orlansky, J. (1983). Effectiveness of CAI: A different finding. *Electronic Learning*, 3(1), 58-60.
- Orlansky, J., & String, J. (1981, Second Quarter). Computer-based instruction for military training. *Defense Management Journal*, 46-54.

## Video Technologies for Instructing

---

**Finding:** Video technologies can simulate world events, equipment, or tasks and can deliver interactive instruction to learners at formal schools and remote worksites.

**Comments:** A variety of telecommunications technologies have potential for delivering instruction to learners at formal schools and remote sites. Blends of technologies can provide learners with new types of instructional experiences that emphasize interaction and individualized learning. Linked video and computer technologies can provide interactive training that incorporates important instructional variables such as immediate feedback, individualized pacing, and almost unlimited combinations of text, images, and natural and synthesized speech. As with other technologies, needs, costs, and effectiveness should be analyzed carefully before any large scale implementation.

Video presentations can enhance effectiveness of computer-based instruction when the learners need to see people or machines in motion. Students who have completed courses providing interactive video presentations often score considerably higher on skill and knowledge tests than do students who completed conventional instruction. Students in self-paced interactive video courses often learn the same or more in less time than do students of lecture-based presentations.

- References:** Bergman, R.E. (1981, November). Technology and training: The shape of tomorrow's seminar. *Performance and Instruction*, 20(9), 17-20.
- DeBlois, M. and others, (1984). Effectiveness of interactive videodisc training: A comprehensive review. *The Monitor Report Series*, 1-20. (ERIC Document No. ED 278 370).
- Fleming, M. L. (1987). Displays and communication. In R. M. Gagné (Ed.), *Instructional technology: Foundations* (233-260). Hillsdale, NJ: Erlbaum Associates.
- Hassett, J., & Dukes, S. (1986, September). The new employee trainer: A floppy disk. *Psychology Today*, 30-36.
- Nugent, G. C. (1987). Innovations in telecommunications. In R. M. Gagné (Ed.), *Instructional technology: Foundations* (261-282). Hillsdale, NJ: Erlbaum Associates.
- Smith, E. E. (1987). Interactive video: An examination of use and effectiveness. *Journal of Instructional Development*, 10(2), 2-10.

## Training Devices for Task Simulation and Practice

**Finding:** Simulators enable learners to acquire the knowledge they need to operate and repair devices, to practice at speeds not constrained by real time, and at a fraction of training cost using actual equipment.

**Comments:** Simulators may be devices that physically resemble actual equipment (a mock-up or part-task trainer) or a type of computer-based instruction in which graphics on a computer screen represent the equipment. In either case, all or part of the equipment functions may be simulated and students can perform manipulations that change the representation of the actual device.

Simulators offer many advantages in training. They are cheaper to practice on than the actual equipment. They are often easier to understand than the actual equipment because they can depict normally invisible functions and events such as electron flows. Based on student performance, the simulator can determine how much practice the student needs and can isolate and repeat the difficult segments of a task. Since events can occur on simulators at speeds that are much faster than real time, the effect of manipulations can be seen quickly and additional practice accomplished quickly. Perhaps of greatest importance is the fact that simulators can incorporate important training variables such as detailed performance evaluation and feedback.

Design, development, and use of simulators require careful planning and special skills. Tryouts with typical students are important to validate the design of the representations. Contrary to popular belief, a simulator's physical similarity to the device it represents does not determine its effectiveness or ensure effective training. Rather, a simulator's effectiveness is a function of the instructional methods incorporated into it to support student learning; for example, how well does the simulator isolate relevant cues while students learn to ignore irrelevant information on a radar scope? Design decisions, therefore, must be related to the cognitive processes required to learn the task rather than particular hardware or medium.

- References:** Blaiwes, A. S., & Regan, J. J. (1986). Training devices: Concepts and progress. In J. A. Ellis (Ed.), *Military contributions to instructional technology* (pp. 83-170). New York: Praeger Publishers.
- Caro, P.W., Shelnuut, J.B., & Spears, W.D. (1981). *Aircrew training devices utilization* (AFHRL-TR-80-35). Wright-Patterson Air Force Base, OH: Logistics and Technical Training Division.
- Half, H. M., Hollan, J. D., & Hutchins, E. L. (1986). Cognitive science and military training. *American Psychologist*, 41(10), 1131-1139.
- Orlansky, J. & String, J. (1981). *Cost effectiveness of maintenance simulators for military training* (IDA Paper P-1568). Alexandria, VA: Institute for Defense Analysis. (ERIC Document No. ED 212 254)
- Prophet, W.W., Shelnuut, J.B., & Spears, W.D. (1981). *Simulator training requirements and effectiveness study (STRES)*. Wright-Patterson Air Force Base, OH: Logistics and Technical Training Division.
- Schneider, W., Vidulich, M., & Yeh, Y. (1982) Training spatial skills for air-traffic control. *Proceedings of the Human Factors Society*, (10-14).

## Distributed Instruction

---

**Finding:** Students not at formal schools can interact with instructors through modern communications technology such as networked computers with or without television.

**Comments:** Through instructional electronics networks, apprentices, alone or in small groups, can learn skills and knowledge where they will use them. A telephone computer network controls audio or electronic exchanges between students and instructors, while satellite, cable, or cassettes deliver video if needed. Participants can work on problems peculiar to their own situation when their scheduled work allows. Variations are possible; for example, participants can delay the interactions by storing questions, answers, and comments until they have time to address them.

Microcomputers can also serve as terminals to remote data banks and network members. Through telephone connections and a centralized message workspace, learners can ask questions or propose solutions to other members sharing the network.

Several sound educational benefits result because distributed instruction:

- enables beginning apprentices to observe interchanges between more experienced apprentices and instructors and to develop their skill in approaching problems gradually;
- reaches learners where and when the training is needed;
- shifts more responsibility for acquiring the skill from the trainer to the learner;
- individualizes the studying and increasing the interaction;
- uses the learner's and trainer's time more productively;
- saves travel time, cost, and time away from the job.

**References:** Bergman, R.E. (1981). Technology and training: The shape of tomorrow's seminar. *Performance and Instruction*, 20 (9), 17-20.

Levin, J. A., Riel, M., Miyake, N., & Cohen, M. (1987). Education on the electronic frontier: Teleapprentices in globally distributed educational contexts. *Contemporary Educational Psychology*, 12(3), 254-260.

Newman, D. (1987). Local and long distance computer networking for science classrooms. *Educational Technology*, 27 (6), 20-23.

## Adopting Training Innovations

---

**Finding:** Managers and training developers can effect the rate at which the schools and instructors adopt and use newly developed training materials and programs.

**Comments:** From the time an instructional development project is first conceived, the training commands and schools should consider the strategies to use to encourage the potential users to adopt the new materials. Too often, materials are adopted only where they were developed--that is, the "not developed here" syndrome. One way of overcoming this attitude is to involve all potential users in the analysis and design phases of innovative courses.

Using an effective person as an agent to manage change is a critical factor in diffusion. The agent studies the potential adopting organization and systematically shows that:

- The innovation has obvious advantages over the existing process, materials, or equipment.
- It is compatible with the existing system.
- Significant research and/or evaluations reveal the innovation's advantage.
- There is a rational sequence for its adoption and application.
- It addresses an identified need of the potential user.
- The innovation will be used for a long time.
- The staff can acquire the skills needed to adopt the innovation.

The manager must concentrate on the potential users and their needs rather than on the material or the innovation, must know as much about the situation as the potential user, be ready to tailor the innovation to the user's needs, and explain the innovation to the potential users.

**References:** Margulies, N., et al. (1973). *Organizational Change: Techniques and Applications*. Glenview, IL: Scott, Foresman.

Nelson, M., & Sieber, S. D. (1976). Innovations in urban secondary schools, *School Review*, 84(2), 213-31.

Rogers, E. (1983). *Diffusion of innovations* (2nd ed.). New York: Free Press.

## for Instructors

---

### Instructors Can:

- 
- Bring good practices to bear on training.
  - Focus classroom activities on learning.
  - Emphasize student learning and achievement.
  - Monitor student studying and adjust their activities to maximize their effort and progress.
  - Give corrective feedback regularly.
  - Promote effective use of instructional time in learning.
  - Learn and use teaching techniques that enhance student learning.
  - Provide well-structured presentations and classroom activities.
  - Arrange many and varied learning opportunities.
  - Create a job-like instructional situation.
  - Emphasize hands-on, job-like performance tests.
  - Test and question students to evaluate their learning progress and maintain motivation to learn.
  - Provide students with opportunities for individualized work.
  - Design out-of-class assignments to increase student achievement.
-

## Rating Instructors

---

**Finding:** Feedback from student ratings of instructors enables instructors to improve their performance.

**Comments:** When educational and training institutions have students rate their instructors, they expect that the instructors will use the ratings to improve their teaching. Evaluation studies show that feedback from the ratings does improve instructor performance.

Research on college teaching revealed that instructors who received mid-semester rating feedback received substantially higher end-of-course ratings than did instructors who were rated only at the end of the semester. Ratings improved even more when instructors discussed the mid-semester ratings with consultants or received other help in interpreting and reacting to the ratings.

Instructors and managers can use student ratings during a course to modify and improve teaching with the same groups of students. Other instructors or training specialists can help individual instructors improve their teaching. As with all feedback generally, its timing and its content influence its effectiveness.

**References:** Cohen, P.A. (1981). Effectiveness of student-rating feedback for improving college instruction: A meta-analysis of findings. *Research in Higher Education*, 13, 321-341.

Cohen, P.A. (1981). Student ratings of instruction and student achievement: A meta-analysis of multisection validity studies. *Review of Educational Research*, 51, 281-309.

McKeachie, W. (1978). *Teaching tips: A guidebook for the beginning college teacher* (7th ed.). New York: Heath.

## Instructor Classroom Role

---

**Finding:** Student activities during learning are more important in determining what is learned than the instructor's presentation. Instructors aid student achievement by getting students to engage in activities that are likely to result in learning.

**Comments:** Typical classroom instruction often places students in a passive role (such as listening or watching), where they learn less than when they are actively involved.

Effective instructors do not merely state many facts and ideas; they know how to get students actively engaged in appropriate learning activities for attaining the desired outcomes. Learning is an active process in the learner; the instructor's task therefore involves more than merely dissemination of information. Instruction must consider factors such as prior knowledge, the context in which the material is presented, the uses intended for the outcomes, and the realization that student understanding of new information depends on how well it relates to their prior knowledge.

Students often begin learning with substantial misconceptions about the material they are studying and its intended use. Even students who get high grades have these misconceptions. Students also make systematic errors owing to misconceptions or erroneous procedures based on their current and prior knowledge. The instructor needs to address the inadequate prior knowledge directly and present instruction likely to remove the misconceptions and faulty information. The instructor must understand how current and prior knowledge determines what the students will learn from new material that conflicts with their existing beliefs. Students should be asked to reveal their misconceptions so that the instruction can confront them.

**References:** Brophy, J. E. (1981). Teacher praise: A functional analysis. *Review of Educational Research*, 51, 5-32.

Good, T. L., & Brophy, J. E. (1984). *Looking in classrooms*. New York: Harper and Row.

Shuell, T. J. (1980). Learning theory, instructional theory, and adaptation. In R. E. Snow, P.-A. Federico, and W. E. Montague (Eds.), *Aptitude, learning, and instruction: Vol. 2, Cognitive process analyses of learning and problem solving* (pp. 277-302). Hillsdale, NJ: Lawrence Erlbaum Associates.

Shuell, T. J. (1986). Cognitive conceptions of learning. *Review of Educational Research*, 56(4), 411-436.

Snow, R. E. and Lowman, D. F. (1984). Toward a theory of cognitive aptitude for learning from instruction. *Journal of Educational Psychology*, 76, 347-376.

## Instructor Classroom Leadership

---

**Finding:** Effective instructor leadership in the classroom promotes effective student learning.

**Comments:** Instructors lead students to learning by focusing on performance, presenting well-conceived learning objectives, conducting regular, and comprehensive evaluations of student learning, having high expectations of all students, and providing a purposeful and peaceful learning environment.

Instructors should protect minority opinions, keep disagreements under control, point out relationships between various opinions and ideas, and remind the class of the variety of potential solutions to a problem.

Instructors can observe each other in the classroom and comment on their observations. This constructive feedback can help the observed instructor become more effective and improve morale.

Good classroom management is essential for classes with problem students such as those who are consistent underachievers, hostile, aggressive, defiant, easily distracted, socially withdrawn, or rejected by the other students.

Instructors should give grades that reflect the student's skill or that the student has achieved objectives as measured by a criterion test and not as a tool for discipline. When students actively participate in their learning, disciplinary problems are reduced.

Instructors must help students perceive the instruction as relevant and interesting, reinforce good behavior, seek friendly personal relationships with the students, help them develop a sense of right and wrong, and encourage them to cooperate with other students and staff.

**References:** Brophy, J.E. (1985). Classroom management as instruction: Socializing self-guidance in students. *Theory Into Practice*, 24(4), 233-240.

Cohen, M. (1982). Effective schools: Accumulating research findings. *American Education*, 18(1), 13-16.

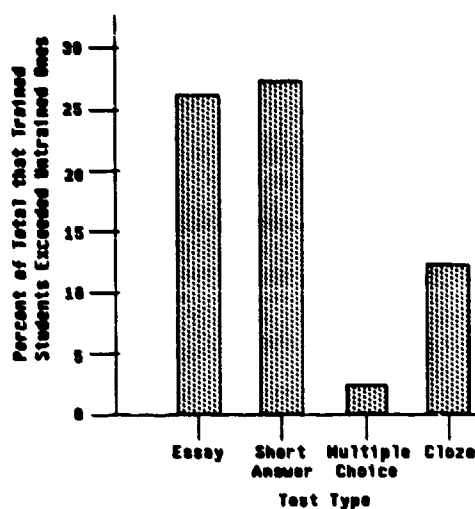
Gold, M., & Mann, D. (1984). *Expelled to a friendlier place: A study of effective alternative schools*. Ann Arbor, MI: The University of Michigan Press.

Zemke, R. & S. (1981, June). 30 things we know for sure about adult learning. *Training/HRD*, 18(6), 45-52.

## Training Students How to Learn from Text

Training in techniques for learning from text materials has a substantial effect on performance on tests covering the content studied.

Students given training in how to study text material outperform students not given training. For example, they were taught how to make a network map of the information in the text, a spatial representation of the information and how to paraphrase, to draw pictorial representations of ideas and concepts in the network. Four different measures were used to examine the effect of the training. As can be seen in the figure, the trained students substantially outperformed untrained ones on essay and short-answer tests. The histogram bars show how much the scores of the trained students exceeded those of untrained students. On a "cloze" test every nth word in the material is deleted, and the student tries to fill in the correct word from memory. Trained students showed superior performance on that type of test also. On a multiple-choice test trained students' superiority was slight. This type of test is not as useful a test for examining student learning and understanding.



**Reference:** Dansereau, D. F. & Brooks, L. W., Holley, C. D., and Collins, K. W. (1983). Learning strategies training: Effects of sequencing. *Journal of Experimental Education*, 51(3), 102-108.

## Teaching Students How to Learn

---

**Finding:** The ways students study influence what and how much they learn. Students can learn effective study strategies.

**Comments:** Good students have been found to use study strategies that other students can be taught to use. Study or learning strategies may affect learner motivation or the way they select, acquire, organize, or integrate new knowledge. For example, learners may coach themselves to reduce anxiety, use imaging to relate vocabulary words and meanings, or summarize and take notes to memorize written material.

Average and low ability students use these strategies less than high ability students. Average ability students can learn the skills; however, low ability students may need to be taught when, as well as how, to use these strategies. Once they have learned the strategies, all students can study and learn more efficiently, but they often need to be encouraged to do so.

Some examples of sound study practices used by better students are to:

- Monitor and adjust the way they study based on:
  - Whether they understand difficult material.
  - How much time they have for studying.
  - How much they know about the material.
  - The standards they must meet.
- Space study sessions on a topic over available time and not to work continuously on a single topic.
- Use the study strategies appropriate for the learning task. For example, use rehearsal and self-testing to memorize ordered lists, take notes that paraphrase a lecture, or organize information in text by identifying the main ideas and relating them prior or current knowledge.
- Assess their progress by frequent self-questioning and modify the strategies as needed.

**References:** Dansereau, D. F. (1985). Learning strategy research. In J. Segal, S. Chipman, & R. Glaser (Eds.), *Thinking and learning skills; Vol. 1: Relating instruction to research* (pp. 209-240). Hillsdale, NJ: Erlbaum Associates.

Dobrovolsky, J. L., McCombs, B. L., & Judd, W. A. (1980, March). *Study skills package: Development and evaluation* (AFHRL-TR-79-43). Brooks AFB, TX: Air Force Human Resources Laboratory.

Weinstein, C. E., & Mayer, R. E. (1986). The teaching of learning strategies. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (3rd Edition). New York: Macmillan Publishing Company.

Weinstein, C. E., Zimmermann, S. A., & Palmer, D. R. (1988). Assessing learning strategies: The design and development of LASSI. In C. E. Weinstein, E. T. Goetz, and P. A. Alexander (Eds.), *Learning and study strategies: Issues in assessment, instruction, and evaluation*. 25-40 San Diego, CA: Academic Press.

## Testing Student Learning

---

**Finding:** Frequent, systematic testing and assessing of student progress informs students about their learning and instructors and managers about strengths and weaknesses in student learning and the instruction.

**Comments:** Instructors test students and assess their work to learn what students already know and what they need to learn. They use various means including observing laboratory exercise performance, giving oral quizzes and tests, assigning homework, asking questions in the classroom, and giving comprehensive performance tests.

Student errors on tests and in class alert instructors to learning problems that need to be corrected. Student motivation and achievement improve when instructors provide prompt feedback on their performance and assignments.

In technical training, assessment should be as job-like as possible. This means emphasizing hands-on performance tests, limiting pencil-and-paper tests to safety and knowledge critical for job performance, and stressing open-book testing in which students use manuals and other references normally available on the job. Frequently tested students outperform less frequently tested ones in the classroom.

Students generally take either knowledge or performance tests. Knowledge tests help instructors find out if the students have learned information important for safety and knowledge important for performance.

Performance tests enable instructors to determine student competence, and identify student and instruction problems. The instructors biggest concern with testing is to identify what the students do not know. Performance difficulties often indicate gaps in student knowledge, and their explanations of their actions or answers to questions can confirm an instructor's inference.

**References:** Bangert-Drowne, R. L. et al. (1986, April). Effects of frequent classroom testing. Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, CA. (ERIC Document No. ED 274 672)

Ellis, J. A. & Wulfeck II, W. H. (1982). *Handbook for testing in Navy schools* (NPRDC SR 83-2). San Diego, CA: Navy Personnel Research and Development Center. (AD-A122 479)

Ellis, J. A. & Wulfeck II, W. H. (1986). Criterion-referenced measurement in military technical training. In J. A. Ellis (Ed.), *Military contributions to instructional technology* (pp. 60-82). New York: Praeger Publishers.

Roid, G. & Haladyna, T. (1982). *A technology for test item writing*. New York: Academic Press.

Samson, G. E., Graue, M. E., Weinstein, T. & Walberg, H. J. (1984). Academic and occupational performance: a quantitative synthesis. *American Educational Research Journal*, 21 (2), 311-321. (ERIC Document No. EJ 303 651)

## Giving Feedback to Students

---

**Finding:** Students who receive constructive feedback about the accuracy and adequacy of their performance become more interested in the class and learn more.

**Comments:** Giving constructive feedback to students about the adequacy and accuracy of their actions is an effective way for instructors to aid student learning. Timely comments about their performance provide important recognition of their effort and help correct errors.

No one method is best for providing feedback to students, but instructors can follow some useful general rules. Regardless of whether or not an answer is correct, the feedback should be prompt and provide useful information. Even after a correct answer, feedback emphasizing the method used to get the correct answer reinforces the solution and, if other students are onlookers, they can understand why the answer is correct.

Instructors should give nonspecific praise and criticism infrequently and, even then, base it on the quality of student performance. It is better to explain correct or incorrect performance than to give only the correct answer or to judge the student performance. Feedback should routinely tell students when they are incorrect, but should focus on the content and explain how to reach the correct answer. Critical feedback, written or spoken, should be given in private and not in front of the class.

By giving constructive, timely feedback, instructors can reinforce and help students develop positive self-esteem as well as improve their performance. Students who believe they can succeed are usually more successful than those who are less sure of their ability. Usually, students who believe they can succeed are more active learners, work independently, cooperate with other students, and achieve more.

**References:** Brophy, J. (1981). Teacher praise: A functional analysis. *Review of Educational Research*, 51 (1), 5-32.

Brophy, J., & Good, T. L. (1986). Teacher behavior and student achievement. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (3rd ed., pp. 328-375). New York: Macmillan Publishing Company.

Lysakowski, R. S., & Walberg, H. J. (1981). Classroom reinforcement and learning: A quantitative synthesis. *Journal of Educational Research*, 75 (2), 69-77.

Orlich, D. (1985). *Teaching strategies, A guide to better instruction*. Lexington, MA: Heath and Company.

Schimmel, B. J. (1983, April). A meta-analysis of feedback to learners in computerized and programmed instruction. Paper presented at the Annual Meeting of the American Educational Research Association, Montreal, Canada. (ERIC Document No. ED 233 708).

## Managing Class Time

---

**Finding:** Students who spend as much time as possible actively engaged in learning learn more than do students who do not.

**Comments:** The time that is allocated for learning by the instructor or instructional program differs from the time that students actually engage in learning. This difference is especially important in laboratory or hands-on training where a limited amount of equipment is available and students can spend much time unproductively watching others. Passive student exposure to laboratory equipment does not mean that students are learning. Similarly, the time students spend in lectures or discussions where material is presented should not be counted as learning time.

Effective instructors determine learning time accurately and use techniques that increase the time students spend on learning activities. For example, they minimize time for breaks and interruption of individual students. Students can help instructors analyze their classroom by identifying distracting events and procedures that could be changed and by accurately reporting the time they are actively learning. Instructors can question students about these issues.

Instructors can increase students' attention to learning and thereby increase learning time and achievement. Questions can focus on material or problems in texts or manuals. Instructors who summarize important information prepare students for studying. Students who are easily distracted may profit from out-of-class assignments that focus on overcoming the distractions and processing relevant content. Explicit feedback to students about their performance helps them learn what is required of them and how to correct their actions.

Instructors who supplement a well-planned training program with these activities can achieve these important goals:

- Capture students' attention.
- Make the best use of available learning time.
- Encourage academic achievement.

**References:** Karweit, N. Time on task reconsidered: Synthesis of research on time and learning. *Educational Leadership*, 41(8), 32-35.

Stallings, J. (1980). Allocated academic learning time revisited: Beyond time on task. *Educational Researcher*, 9(11), 11-16.

Walberg, H. J. (1984). What makes schooling effective? A synthesis and critique of three national studies. *Contemporary Education Review*, 1(1), 22-34.

Wittrock, M. C. (1986). Students' thought processes. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (3rd ed.). New York: MacMillan Publishing Company.

## Cooperation in Learning

---

**Finding:** Cooperating with other students in learning often improves learning.

**Comments:** Organizing students into small study groups improves their performance on achievement tests. This arrangement promotes positive attitudes of students toward each other and toward learning and school. It has potential to assist subsequent "team" activity, which is of obvious importance for crew training in the military. Small groups of two or three students working together are preferable. It is important to make sure that one student does not dominate the others, thereby limiting their opportunity to learn. This can be achieved by testing them separately or by instituting other procedures that make sure that each student spends an appropriate amount of time actively learning.

Students tend to avoid activities that they believe will result in failure. A competitive situation arouses the need either to achieve success or avoid failure. Encouraging cooperation, rather than competition, among students promotes more effective learner achievement and productivity.

Self-esteem and ego are on the line when students are asked to try a new behavior in front of their class. Bad experiences in traditional education, feelings about authority, and the preoccupation with events outside the classroom all affect experiences in class. Exposing inadequate performance in class will probably reduce student interest in learning and lead to a negative attitude toward the instructor and the organization.

Instructors can increase student learning by promoting cooperation rather than competition among the students. Students competing for grades or other extrinsic goals focus on beating other students rather than on understanding the course material and learning how to work as a team member.

**References:** Johnson, D. W., Johnson, R. T., & Maruyama, G. (1983). Interdependence and interpersonal attraction among heterogeneous and homogeneous individuals: A theoretical formulation and a meta-analysis of the research. *Review of Educational Research*, 53, 5-54.

Johnson, D. W., Maruyama, G., Johnson, R., & Nelson, D. (1981). Effects of cooperative, competitive, and individualistic goal structures on achievement: A meta-analysis. *Psychological Bulletin* 89 (1), 47-62.

Slavin, R. E. (1983). *Cooperative learning*. New York: Longman, Inc.

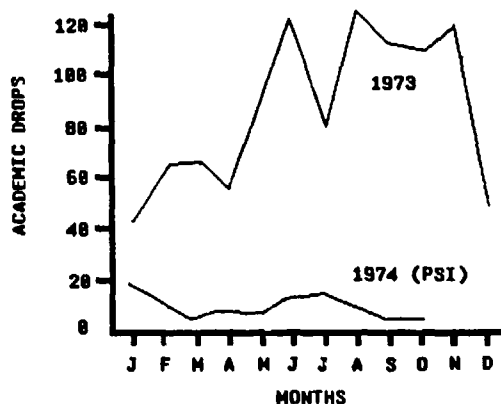
Smith, K. A., Johnson, D. W., & Johnson, R. T. (1981). The use of cooperative learning groups in engineering education. In L. P. Grayson & J. M. Biedenbach (Eds.), *Proceedings: Tenth Annual Frontiers in Education Conference* (pp. 29-32), Washington, DC: American Society for Engineering Education.

## Peer Proctoring Reduces Attrition

Peer proctoring in a Navy technical school substantially reduced attrition in contrast to attrition in the standard course.

Senior students assist individual students in the Personalized System of Instruction (PSI) which is the proctor model. They make sure that learners do assignments, take tests, and restudy materials when necessary. The PSI was developed to assist in college teaching, but has been utilized elsewhere. PSI courses are mastery oriented, student proctored, self-paced, and use printed study guides to guide students' studying, and occasional lectures and discussion to stimulate and motivate the students. Reviews of numerous studies comparing PSI taught courses with those taught by standard classroom procedures find substantially better achievement for PSI students on various tests given during and after the course, even larger superiority on tests given weeks or months later, and better attitudes toward the course.

In a Navy technical training program in Propulsion Engineering, implementation of PSI resulted in a substantial reduction in attrition as shown in the figure that follows. The graph shows the number of students dropped from the course for several months in 1973 when it was fixed length and primarily lecture-based and several months in 1974 when the PSI was implemented.



**References:** Kulik, J. A., Kulik, C. C. Cohen, P. A. (1979). A meta-analysis of outcome studies of Keller's Personalized System of Instruction. *American Psychologist*, 34, 307-318.

Keller, F. S. (1968). Good-bye, teacher ... *Journal of Applied Behavioral Analysis*, 1, 78-89.

McMichael, J. S., Brock, J. F., & Delong, J. (1976). Job-relevant Navy training and Keller's Personalized System of Instruction: Reduced attrition. *Journal of Personalized Instruction*, 1(1), 41-44.

## Peer Teaching

---

**Finding:** Peer "teachers" and their students receive higher grades on tests and develop more positive attitudes toward the courses with peer teaching.

**Comments:** Peer interaction improves the academic performance and attitudes of the students who receive tutoring and those who provide it. Instructors can supplement regular classroom and laboratory teaching with peer teaching. It helps slower and underachieving students learn and succeed in school. The peer teachers benefit from preparing and giving lessons to other student because they learn more about the lessons they prepare and present.

Peer teaching can take a variety of forms such as:

- Teacher assistants leading discussion groups, seminars, or tutorial groups.
- Senior students assisting individual students (called the proctor model).
- Student-led learning groups that have no instructor.

Student coaching usually raises achievement test scores. The effects are greatest in long cognitive courses and extensive drill-and-practice courses. Short test-taking oriented courses show the least improvement as a result of coaching methods.

Students bring a lot of invaluable life experiences into the classroom, which should be acknowledged and used. Students can learn much from dialogue with respected peers.

**References:** Bangert-Drowns, R.L., Kulik, J.A., & Kulik, C.C. (1983, Winter). Effects of coaching programs on achievement test performance, *Review of Educational Research*, 53 (4), 571-585.

Cohen, P. A., Kulik, J. A., & Kulik, C. C. (1982, Summer). Education outcomes of tutoring: A meta-analysis of findings. *American Educational Research Journal*, 19 (2), 237-248.

Goldschmid, B., & Goldschmid, M. L. (1976). Peer teaching in higher education: A review. *Higher Education*, 5(1), 9-33.

Slavin, R. E. (1983). *Cooperative learning*. New York: Longman, Inc.

## Instructor Presentation Stimulates Learning

---

**Finding:** Students perform best when their instructors inspire them to take an active role in their learning.

**Comments:** Good instructors are subject matter experts in what they teach, are well prepared for student questions, and stimulate student interaction. Because students can remember only a small amount of material presented orally or visually, emphasizing the systematic, logical structure of the material can help students learn and remember. It is also advisable to present no more than two or three main ideas in a 15-minute segment.

Instructors can use techniques to stimulate students to assume an active role in understanding what is taught. For example, students learn best when they receive summaries of the main ideas or goals of the presentation, reasons for learning the information, and illustrations, tables, and charts for later study or discussion in class.

Instructors who ask questions and present problems force students to think of the appropriate answers and generate solutions. To encourage retention, instructors should review or summarize major teaching points to remind the students why they are important. To elicit more active learning in students, instructors can: (1) ask students to summarize, (2) involve students by providing obviously wrong information, which challenges them to think about and discuss their knowledge and beliefs, (3) divide students into small groups to get them involved in discussions, and (4) ask questions randomly during lectures. Student involvement increases when instructors relate directly *relevant* "war stories" or anecdotes and explain their relevance clearly.

When instructors tell students what they are expected to learn and demonstrate the steps needed to accomplish a task, students learn better. This "direct instruction" takes the students through the learning steps systematically, helping them to see both the purpose and the result of each activity. Direct instruction is particularly effective in teaching basic skills and in helping experienced higher ability students master complex materials and develop individual study skills.

**References:** Rosenshine, B., & Stevens, R. (1986). Teaching functions. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (3rd ed.). New York: MacMillan Publishing Company.

Rothkopf, E. Z. (1981). A macroscopic model of instruction and purposeful learning. *Instructional Science*, 10(2), 105-122. (ERIC Document No. EJ 250 116)

Sullivan, H., & Higgins, N. (1983). *Teaching for Competence*. New York: Teachers College, Columbia University.

Thiagarajan, S. (1985). 25 ways to improve any lecture. *Performance & Instruction Journal*, 24(10), 22-24.

Walberg, H. J. (1984, May). Improving the productivity of America's schools. *Educational Leadership*, 41(8), 19-36.

## Practice

---

**Finding:** Practicing lesson-related tasks promotes learning new skills.

**Comments:** Students learn more by doing than by watching or listening. They should have opportunities to practice the steps of any procedures they are learning. They should practice the new behaviors in a variety of situations that represent job conditions.

Instructors need to provide opportunities to practice since practice improves performance. Separate each repetition of identical or similar drills with other drill activities.

Emphasize the key points during practice to increase the likelihood that students address and recall these key points. Explicit feedback about performance helps students identify and correct performance difficulties.

The amount of practice required to perform a task correctly usually increases with the complexity of the task. In very complex tasks, however, components of the tasks need to be learned and practiced first and then combined later. For example, in air-traffic control training students spend much time practicing the entire task, they learn it very slowly, and they may not attain acceptable performance levels by the end of the training program.

Sometimes, using the wrong learning strategy prevents learning with practice. In seemingly simple tasks such as memorizing strings of digits, students can practice for hours without improving their performance unless they are shown or discover how to use grouping and coding schemes to help them learn.

**References:** Gettinger, M. (1984). Individual differences in time needed for learning: A review of the literature. *Educational Psychologist*, 19(1), 15-29.

Robinson, E. R. N., & Knirk, F. G. (1984). Interfacing learning strategies and instructional strategies in computer training programs. In F. A. Muckler (Ed.), *The Human Factors annual review* (vol. 1, pp. 209-238). Santa Monica, CA: Human Factors Society.

Rothkopf, E. Z., & Coke, E. U. (1963). Repetition interval and rehearsal method in learning equivalences from written sentences. *Journal of Verbal Learning and Verbal Behavior*, 2, 406-416.

Schneider, W. (1985). Training high-performance skills: Fallacies and guidelines. *Human Factors*, 27(3), 285-300.

Sullivan, H., & Higgins, N. (1983). *Teaching for Competence*. New York: Teachers College, Columbia University.

## Promote Development of Mental Models

---

**Finding:** When students are asked to act in accordance with a prescribed "model" of performance, they develop conceptual understanding that guides competent performance more effectively.

**Comments:** Learning involves the development of qualitative conceptual structures that are called "mental models." A person makes use of an internal model of the world to understand, explain, and predict things about the world. If people carry a small-scale-model of external reality in their heads, they are able to try out various alternatives, decide which of them is best, react to future situations before they occur, utilize knowledge of past events in dealing with the present and future. Models allow people to generate descriptions of system purpose and form or explain system functioning and observed states, and to make predictions of future states. These models provide a means for organizing and reorganizing memory and deciding on actions.

Mental models evolve naturally through the interaction of the learner and particular environments. If this is so, we can devise methods to promote their development. One way is representing the functionality of the work environment, and the devices/equipment in it. In addition, providing external guidance or directions, i.e., telling what to do and how to do it, allows the buildup of experience coupled with important cognitive information that, once internalized, will guide performance. An accurate mental model develops from the way events flow on-the-job, how devices function and can malfunction, and serves as the scheme to guide personal action when new problems are encountered. Having students describe in detail the steps they're using while performing identifies errors and competence develops faster and transfers readily to the work environment.

As an example, take the task of training students to solve problems in electric circuits, thermodynamics, or mechanics. By guiding students through the steps, explaining why they're taken, and then having students describe the factors and their interactions as they solve subsequent problems, they learn rapidly and accurately. Instructors can check the accuracy of a student's initial representation and provide feedback. It focuses students' attention on the need for careful representation of all facets of the problem and provides the basis for correct solutions. Thus, by concentrating on accurate initial description of the problem, students learn to internalize the procedures as part of their mental model, which they use habitually in approaching problems later on.

**References:** Anderson, R. C. (1977). The notion of schemata and the educational enterprise: General discussion of the conference. In R. C. Anderson, R. J. Spiro & W. E. Montague (Eds.), *Schooling and the acquisition of knowledge* (415-431). Hillsdale, NJ: Erlbaum Associates 415-431.

Gentner, D., & Stevens, A. L. (1983). *Mental models*. Hillsdale, NJ: Erlbaum Associates.

Heller, J. I., & Reif, F. (1984). Prescribing effective human problem-solving processes: Problem description in physics. *Cognition and Instruction*, 1(2), 177-216.

Kieras, D. E. (in press). What mental model should be taught: Choosing instructional content for complex engineered systems. In J. Psotka, D. Massey, and S. Mutter (Eds.), *Intelligent tutoring systems: Lessons learned*. Hillsdale, NJ: Erlbaum Associates.

## Motivating Students

---

**Finding:** Learning improves when students know how to set their own goals and how to achieve them.

**Comments:** Students who believe they can control their own learning experience believe they can handle most academic challenges. However, not all students can take charge of their own learning without encouragement and help. Students can learn to set daily training goals, monitor their progress toward these goals, and chart their progress to provide their own reinforcement. Instructors should ask their students about their progress toward these goals and then provide positive verbal encouragement and reinforcement.

Extrinsic rewards, such as grades, scores, and points, while necessary, may not motivate students as well as goals and rewards based on direct involvement with the ongoing training. Focus student attention on long-term competence rather than extrinsic rewards.

Instructors will find the following techniques useful to promote this focus.

- Provide students with feedback that informs them about errors and how to improve performance.
- Encourage students to persist at learning when they make mistakes.
- Point out the relevance of new information to what the students already know.

Instructors frequently reward learner effort so that many learners concentrate on working hard and fast rather than on the quality of their work. Instructors, thus, should examine their reward system. If they reward effort, they need to explain to the learner the extent to which the reward is for effort and/or the quality of their performance. Under these conditions, the learners will learn to temper the speed of completing tasks by considering the quality of their work.

Instructors should not let students who are failing believe that they are failing because they lack ability. If they believe this, they may develop a pattern of hopelessness and stop trying. Instructors should help learners overcome obstacles and devote effort to learning if there is any chance the individuals can succeed. Instructors should focus on motivating their students and on relevant learning tasks. They should reward less capable students for their progress and challenge more capable students according to their abilities.

**References:** Erickson, S.C. (1984). *The essence of good teaching*. San Francisco: Jossey-Bass.

Horn, E., & Walberg H. (1984). Achievement and interest as functions of quantity and level of instruction. *Journal of Educational Research* 77(4), 227-232.

Rubin, L.J. (1985). *Artistry in teaching*. New York: Random House.

Uguroglu, M., & Walberg, H. (1979). Motivation and achievement: A quantitative synthesis. *American Educational Research*, 16(4), 375-389. (ERIC Document No. ED 206 043)

## Student Control of Learning

---

**Finding:** Students' perception of who controls the key events in learning significantly affects their academic achievement.

**Comments:** In the classroom, students generally attribute their learning success to a combination of ability, effort, task difficulty, and luck. They believe that if they can significantly control their learning, they can also organize their environment for maximum success; that is they can "make their own luck."

Civilian schools have repeatedly demonstrated that learning disabled and other slower students tend to think that other individuals cause their successes and failures. Successful students are more likely to recognize their responsibility for their achievement. According to recent evidence, student perceptions about who caused their successes and failures depend on situational factors. Certainly instructors can change these perceptions. Feedback pointing out the quality of performance and how to improve it can teach slower students to recognize that they are responsible for their learning and performance.

- References:** Bannister, B. D. (1986). Performance outcome feedback and attributional feedback: Interactive effects on recipient responses. *Journal of Applied Psychology*, 71 (2), 203-210.
- Bar-Tal, D. (1978). Attributional analysis of achievement-related behavior. *Review of Educational Research*, 48(2), 259-271.
- Kennelly, K., & Kinley, S. (1975). Perceived contingency of teacher administered reinforcements and academic performance of boys. *Psychology in the Schools*, 12, 449-453.
- Schunk, D. H. (1985). Self-efficacy and classroom learning. *Psychology in the Schools*, 22, 208-223.
- Stipek, D. J., & Weisz, J. R. (1981). Perceived personal control and academic achievement. *Review of Educational Research*, 51 (1), 101-137.
- Uguroglu, M., & Walberg, H. J. (1979). Motivation and achievement: A quantitative synthesis. *American Educational Research*, 16 (4), 375-389. (ERIC Document No. 66 04352)

## Out-of-Class Assignments

---

**Finding:** Student performance improves significantly when instructors regularly give out-of-class assignments, make sure they are completed, and give explicit feedback about the adequacy of the completed assignment.

**Comments:** Students learn significantly more from their assignments when instructors write comments and grades on student papers. Furthermore, students in courses that require out-of-class assignments learn more than do students in courses without such assignments. The time students spend on relevant out-of-class assignments benefits them as much as in-class learning time.

Instructors can use out-of-class assignments to increase practice, which can be especially helpful for lower achievers. Low ability students who spend several hours on out-of-class assignments often obtain grades as high as students with greater ability who do no extra assignments. These assignments boost student achievement because they increase total study time, which influences how much a student learns. This can be helpful for all students, but may be especially important for those who are lower achievers.

Students are more willing to do assignments they consider useful. To benefit student learning, instructors can give the same care to preparing the out-of-class assignments as they give to classroom instruction, treat them as an integral part of instruction, evaluate them, and count them as part of the course requirements.

## References:

- Graue, M. E., Weinstein, T., & Walberg, H.J. (1983). School-based home instruction and learning: A quantitative synthesis. *Journal of Educational Research*, 76(6), 351-360.
- Paschal, R. A., Weinstein, T., & Walberg, H.J. (1984). The effects of homework on learning: A quantitative synthesis. *Journal of Educational Research*, 78(2), 97-104.
- Walberg, H. J. (1983). Scientific literacy and economic productivity in international perspective. *Daedalus*, 112(2), 1-28.
- Walberg, H. J. (1983). Synthesis of research on teaching. In M.C. Wittrock (Ed.), *Third handbook of research on teaching*. Washington, DC: American Educational Research Association.
- Walberg, H. J. (1984). Improving the productivity of American's Schools. *Educational Leadership*, 41(8), 19-36.
- Yeshurun, S. (1973). A reinforcement study on service courses in mathematics and statistics. *International Journal of Mathematics Education in Science and Technology*, 4(2), 127-132.

## for Training Specialists

---

### Training Specialists Can:

- 
- Become assertive instructional leaders by emphasizing factors that bring about excellence.
  - Learn and understand scientific bases for training excellence.
  - Expect high quality and productivity from staff, instructors, and students.
  - Implement and monitor in-service staff training.
  - Monitor and evaluate instructors, and instruction.
  - Promote interaction among instructors.
  - Protect instruction from irrelevant demands.
  - Develop well-structured, work-like training environment to support student learning.
  - Adjust training to goals and to learners through detailed evaluation of performance.
  - Assist instructors in providing feedback to students.
  - Monitor development and empirical evaluation of training technologies.
  - Analyze and propose improvements in training effectiveness and efficiency.
  - Provide input to higher management regarding training policy.
-

## Systematic Approaches to Training Design

---

**Finding:** Systematic training design models provide tools for planning, organizing, and managing instructional development and limit content to that clearly needed.

**Comments:** Systems approaches to instructional design all involve the same general steps necessary to produce instruction likely to support the intended learning by students. These systems models make sure that every piece of instruction has recognizable elements and is tied to an analysis of needs and tasks to be learned. They assist the management of training development by: making training congruent with job-tasks without irrelevant content, evaluating training effectiveness and revising inadequate materials, making media development more efficient, promoting efficient use of time, and allowing for structured resource management and planning.

The quality of instruction developed using systems approach models depends on the skill of the personnel using the procedures. Navy trainers receive only brief training in the use of these procedures. Insufficient understanding about how learning occurs prevents the development of simple, yet general and useful, theories of how to make it occur. Until this process is better understood, clear and simple prescriptions for devising instruction will not be available for them to follow.

Since the adequacy of instruction thus depends on the level of knowledge, experience, and skill of developers, low levels lower the quality of materials. This makes empirical tryouts of the instructional materials and system with students very important. Many of the research findings in this book provide useful information for designing instruction. But, developers need to become aware of these tried-out results and learn how to incorporate them into the instruction they design and develop.

An attempt to aid the instructional design process research knowledge led to the development of a useful quality control procedure. The Instructional Quality Inventory (IQI) is a method for reviewing objectives and checking their congruency with associated training and test items. When applied to existing programs or during the development of new courses, this procedure focuses instructional developers on the objectives and course requirements during the development of instructional materials and test items.

**References:** Andrews, D. H., & Goodson, L. A. (1980) A comparative analysis of models of instructional design. *Journal of Instructional Development*, 3(4), 2-16.

Branson, R. K. & Grow, G. (1987). Instructional systems development. In R. M. Gagné (Ed.), *Instructional technology: Foundations* (pp. 397-428). Hillsdale, NJ: Lawrence Erlbaum Associates.

Montague, W.E., Wulfeck, W.H., & Ellis, J.A. (1983). Quality CBI depends on quality instructional design and quality implementation. *Journal of Computer-Based Instruction*, 10(3 & 4), 90-93.

Montague, W.E., Ellis, J.A., & Wulfeck, W.H. (1983). *The Instructional quality inventory (IQI): A formative evaluation tool for instructional systems development* (NPRDC TR 83-31). San Diego, CA: Navy Personnel Research and Development Center.

Morgan, R. M. (1987) Planning for instructional systems. In R. M. Gagné (Ed.), *Instructional technology: Foundations* (pp. 379-396). Hillsdale, NJ: Lawrence Erlbaum Associates.

## Training Objectives

---

**Finding:** Training objectives that reflect the training requirements directly are easy to see and test.

**Comments:** The use of measurable or observable training objectives helps ensure consistency between the job task, training objectives, course content and test items.

When training materials include the objectives, learner confidence improves and learner anxiety decreases. Including objectives seems to be more effective in courses involving difficult text materials than in courses with easier or more understandable texts.

While objectives may be easier to write for concrete procedures than for more academic content areas such as history, no evidence suggests that objectives are more useful for one content area than another.

Expanding the task statements requiring instruction into objectives requires clarifying the behaviors, identifying the relevant conditions under which the behaviors are to be displayed, and specifying standards used to specify adequate performance.

**References:** Lawton, J.T., & Wanska, S. (1977). Advance organizers as a teaching strategy: A reply to Barnes and Clawson. *Review of Educational Research*, 47(1), 233-244.

Kaplan, R., & Rothkopf, E.Z. (1974). Instructional objectives as directions to learners: Effect of passage length and amount of objective relevant content. *Journal of Educational Psychology*, 66(3), 448-456. (ERIC Document No. EJ 106 722)

Rothkopf, E. Z. & Kaplan, R. (1972) An exploration of the effect of density and specificity of instructional objectives on learning from text. *Journal of Educational Psychology*, 63, 295-302.

Sullivan, H., & Higgins, N. (1983). *Teaching for Competence*. New York: Teachers College, Columbia University.

## Writing Text Materials

**Finding:** Enhancement of text in books or manuals through orientation, summaries, examples and diagrams can aid student comprehension and learning.

**Comments:** Much training is accomplished through written descriptions or discussion. Texts are prepared to serve as a basis for student learning by providing facts, examples, and explanations. To learn, students must understand the materials and how they can apply the information. Descriptions, instructions, and explanations are often difficult to understand because of terminology, inadequate connections to student knowledge, or a "topic-orientation" that tells all about a subject, but not "what a person does" or "how to do it."

Writing should be performance-oriented, rather than topic-oriented. Topic-oriented writing looks like reference material aimed at a general, unspecified audience, telling all about a subject and not how to apply the information. Performance-oriented writing focuses on specific users; describes their roles, tasks, and responsibilities; and gives them the information they need about how to perform. The advantage of performance-oriented text is that readers do not have to infer and conceptualize what to do; it is stated explicitly.

Several techniques can be used to improve student comprehension of text.

- Pre presentation summaries or "advance organizers" outline what is to be learned, provide structure, and improve learning.
- Inserting pictures showing spatial relationships, object form, or internal structure can be powerful aids to comprehension.
- Concrete examples can clarify abstract ideas or depict how principles work.
- Methods that put demands on the trainee in reading and "processing" the text are especially useful.
- Questions inserted before or after text segments can help students to identify important information, and make desired inferences.
- Asking students to relate new information to what they already know or paraphrase the content aids learning.
- Writers can ask students to construct a diagram or "map" depicting the relationship of ideas in text to aid comprehension and remembering the information.

**References:** Gagné, R. M. (1986). Instructional technology: The research field. *Journal of Instructional Development*, 8(3), 7-14.

Jonassen, D.H. (1985). *The technology of text. Volume 2: Principles for structuring, designing and displaying text*. Englewood Cliffs, NJ: Educational Technology Publications.

Kem, R. P., Sticht, T. G., Welty, D., & Hauke, R. N. (1976, November). *Guidebook for the development of Army training literature*. Alexandria, VA: U. S. Army Research Institute for the Behavioral and Social Sciences.

Nugent, G.C. (1982). Pictures, audio, and print: Symbolic representation and effect on learning. *Educational Communication and Technology Journal*, 30, 163-174.

Rothkopf, E. Z. (1982). Adjunct aids and the control of mathemagenic activities during purposeful reading. In W. Otto & S. White (Eds.), *Reading expository material* (pp. 109-138). New York: Academic Press.

## Readability of Training Materials

---

**Finding:** Readability scores indicate approximately how much difficulty students will have in reading or listening to training materials.

**Comments:** Readability formulas predict how well military personnel of varying reading ability can recall text they have read or heard. However, their usefulness for predicting comprehension of instruction is limited because they do not:

- Provide precise estimates of difficulty.
- Estimate the difficulty of non-text materials such as tables and figures that make up much of the instruction in technical training courses.
- Take into account how the text materials will be used; for example, whether they are studied and learned or read while performing.
- Take into account students' background knowledge in the area and related areas. Students with a lot of background knowledge can attain high comprehension while having reading ability several grade levels lower.
- Provide specifications for writing readable materials; one should not write to the formula.

Issues other than readability should be considered in developing instruction. For example, performance-oriented text is recommended in manuals over topic-orientation. Topic-oriented text tells the reader everything you want to know about the topic, but it does not tell what action(s) are to be performed. A reader must infer what to do. Performance-oriented text explicitly tells the reader what actions are expected of them. Surprisingly, technical manuals and texts are often topic-oriented.

- References:** Duffy, T. (1985). Readability formulas: What's the use? In T. M. Duffy & R. Waller (Eds.), *Designing usable texts*. New York: Academic Press.
- Kern, R. (1979). *Usefulness of readability formulas for achieving Army readability objectives: Research and state-of-the-art applied to the Army's problem*. Fort Benjamin Harrison, ID: Technical Advisory Service, U. S. Army Research Institute. (AD-A086 408/2)
- Kern, R. Sticht, T., Welty, D., & Hauke, R. (1977). *Guidebook for the development of Army training literature (P-75-3)*. Alexandria, VA: U. S. Army Research Institute for the Behavioral and Social Sciences. (AD-A033 935)
- Sticht, T. (1972). Learning by listening. In R. Freedle & J. Carroll (Eds.), *Language comprehension and the acquisition of knowledge*. Washington, DC: V. H. Winston & Sons.
- Sticht, T. (1985). Understanding readers and their uses of text. In T. M. Duffy & R. Waller (Eds.), *Designing usable texts*. New York: Academic Press.
- Sticht, T., Armijo, L., Weitzman, R., Koffman, N., Roberson, K., Chang, F. & Moracco, J. (1986). Teachers, books, computers, and peers: Integrated communications technologies for adult literacy development (Summary progress report). Monterey, CA: U. S. Naval Postgraduate School.

## Learning Built on Knowledge

---

**Finding:** Students learn best when instruction is adapted to their existing knowledge and background.

**Comments:** Trainees bring a great deal of life experience into the classroom, an invaluable asset to be acknowledged, tapped, and used. Adults learn much from talking to respected peers. Training materials need to reflect the student's entering or existing knowledge and experiences.

It may not be critical for educators and students to cover all topics and subjects equally well. Because human energy and time are finite, trying to master a little of everything may sacrifice efforts to get to the bottom of a question, to pursue a skill to one's personal limit, to acquire exceptional expertise, to encourage and recognize it in others, and to appreciate groups that combine diverse, specialized skills.

Knowledge of structure is required for a full understanding of the subject matter. Structural knowledge enhances retention of the subject matter, facilitates problem solving, and leads directly to transfer to similar and (perhaps) new situations. Structural knowledge may also result in intellectual excitement and an aptitude for learning.

**References:** Bloom, B. (1976) *Human characteristics and school learning*. New York: McGraw-Hill.

Walberg, H. J., Strykowski, B., Rovai, E. & Hung S. (1984). Exceptional performance. *Review of Educational Research*, 54(1), 87-112. (ERIC Document No. ED 72-07997)

Shavelson, R. J. (1974). Methods for examining representations of a subject-matter structure in a student's memory. *Journal of Research in Science Teaching*, 11(3), 231-249.

## Using Examples and Nonexamples

**Finding:** Providing students with representative good examples and contrasting them with bad examples teaches them desired knowledge and skills.

**Comments:** One problem encountered in developing instruction is presenting the subject matter to be learned in a form that promotes student learning. One technique for accomplishing this goal involves presenting contrasting examples that are accurate or positive representations with those that might be, but are nonexamples. Nonexamples refine the definitions or concepts being investigated by the learner. The contrast develops the learners' representation or knowledge.

It is necessary to collect a variety of examples that are not ambiguous or confusing and illustrate the task so that the student will understand the problem being studied and not acquire misconceptions. Each example must be complete and self-contained. Each should contain the necessary critical features, or attributes so that the student can observe their presence or absence to construct adequate generalizations or representations of the task.

The form and fidelity of each example must adequately represent the critical features of the task. Examples should be as divergent as possible while belonging to the task being taught to prevent irrelevant features from being encoded into the generalization while facilitating the formation of appropriate conception. Avoid overly extreme variations as they make examples difficult to understand or demand skills the student may not have. Easier examples should be provided early in the lesson with a gradual increase in difficulty.

Use attention focusing devices to direct student attention to critical features, to the confusing features, and to the absence of critical features. Learners tend to respond to similar sets of stimuli in similar ways even when the response may be incorrect in one situation. Discrimination is facilitated by exposing learners to examples paired with appropriate nonexamples which focus on the critical differences so they may be easily identified.

Just as students learn from their mistakes, they learn from examples which do not reflect the instruction; instead, non examples refine and clarify definitions and illustrations.

**References:** Bloom, B. S. (1968). Learning for mastery. *Evaluation Comment*, 1, 1-12.

Gagné, E. D. (1985). *The cognitive psychology of school learning*. Boston: Little, Brown and Co.

Gagné, R. M. (1985). *The Conditions of learning and theory of instruction*. New York: Holt, Rinehart and Winston.

Merrill, M. D. (1983). Component display theory. In C. M. Reigeluth (Ed.), *Instructional design theories and models: an overview of their current status*. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Merrill, M. D. (1983). A lesson illustrating component display theory. In C. M. Reigeluth (Ed.), *Instructional design theories and models: an overview of their current status*. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Merrill, M.D., & Tennyson, R.D. (1977). *Teaching concepts: an instructional design guide*. Englewood Cliffs, N.J.: Educational Technology Publications.

## Motivating Student Learning

---

**Finding:** When instruction gets the student's attention, is perceived as relevant and as having attainable goals, and provides frequent testing and explanatory feedback, students work hard, achieve well, and enjoy learning.

**Comments:** Four classes of factors influence student motivation to learn and determine their achievement. Including these factors in the design and development of instruction can have beneficial effects on student achievement.

- Instruction that is attractive and exciting is especially useful to gain students' attention or interest. Therefore, instruction should include incongruous, or novel, or attractive material that stimulates their curiosity and makes them eager to engage or study the material.
- Students' understand the relevance of instruction when objectives are explained to them and new learning is related to their past experience and knowledge. Presentations need to explain the goals of the instruction, how the knowledge is to be used, and the role trainees will play in the work assignment when training is finished.
- Providing instruction that allows students to proceed through a sequence of graded steps maximizes the likelihood of learning and develops confidence in their ability to succeed. If students fail to solve learning problems, they tend to reduce effort expended in learning. Segments of instruction need to be arranged to build students' expectation that they can achieve the course goals with sufficient effort. Thus, presenting simpler materials and problems first, arranging objectives in a progressive, logical sequence, and applying other techniques that facilitate making correct actions or explain adequate behavior, all motivate learning.
- Feedback explaining the adequacy and inadequacy of learning tests and social rewards for expended effort influences student satisfaction. To stimulate student satisfaction, praise for accurate performance, and informative feedback work better than threats or negative comments. Feedback given soon after performance should emphasize what are acceptable aspects of performance. Information correcting errors or guiding performance may be most useful given just before another opportunity to perform.

**References:** Erickson, S.C. (1984). *The Essence of Good Teaching*. San Francisco: Jossey-Bass.

Keller, J. M. (1983). Motivational design of instruction. In C. M. Reigeluth (Ed.), *Instructional-design theories and models: An overview of their current status*. Hillsdale, NJ: Lawrence Erlbaum Associates.

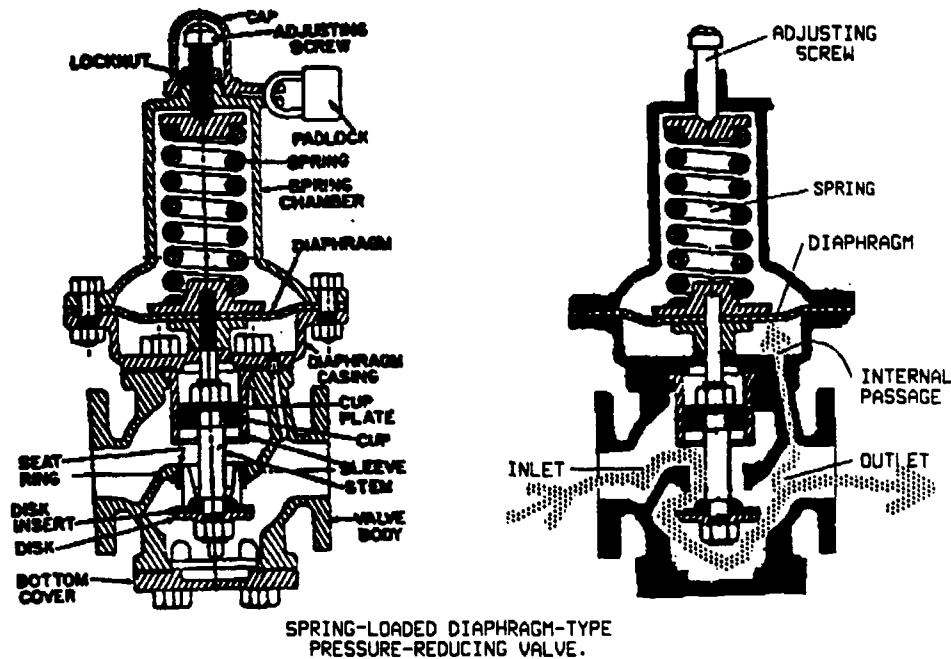
Keller, J. M., & Dodge, B. (1982, September). *The ARCS model of motivational strategies for course designers and developers*. Ft. Monroe, VA: Training Developments Institute.

Horn, E., & Walberg H. (1984). Achievement and interest as functions of quantity and level of instruction. *Journal of Educational Research*, 77(4), 227-232.

Uguroglu, M., & Walberg, H. (1979). Motivation and achievement: A quantitative synthesis. *American Educational Research*, 16(4), 375-389. (ERIC Document No. ED 206 043)

## Effective Illustration

Two illustrations are contrasted in the following figure. The valve on the left is from a Navy rate training manual. As a depiction for explaining how such valves operate, it is confusing and cluttered. It needs to be simpler and show only those parts most intimately involved in the process of reducing pressure from one level to another. Irrelevant labeling and construction detail were removed on the valve at the right to show the parts most important for explaining how the valve works.



Once it is decided that an illustration is required to support learning, a simple illustration depicting just the relevant detail is preferable. The design of a display is determined by attention to the perceptual limitations of students, limits on their ability to process information, and knowing about what students know and understand. Since these characteristics are primarily qualitative, tryouts with typical students are useful for validating design decisions and revising illustrations.

**Reference:** Fleming, M. L. (1987). Displays and communication. In R. M. Gagné (Ed.), *Instructional technology: Foundations*. Hillsdale, NJ: Lawrence Erlbaum Associates.

## Designing Effective Illustrations and Graphs

---

**Finding:** Diagrams, graphs, photographs, and illustrations can improve student learning.

**Comments:** Illustrations enhance text instruction by helping the students perceive and remember the instruction. Illustrations should be as simple as possible to reduce potential confusion with irrelevant details. For that reason, line drawings are often more effective than complex drawings or photographs. Color illustrations are needed only when color itself is important to cue what is being learned.

Pictures or other illustrations not directly related to the presentation are often more distracting than helpful. Highlighted or labeled information can aid learning, but avoid confusing clutter. Several illustrations to show the various switches or components relevant to the current instruction are more comprehensible than one cluttered one.

The use of color may encourage students to examine the material. In these cases, the advantages outweigh the potential confusion. Animation, use of many visuals changing at a rapid pace, may increase student attention to a presentation; this technique may be used for training where the students may have little interest in the course or content.

- References:** Levie, W.H., & Lentz, R. (1982). Effects of text illustrations: A review of research. *Educational Communication and Technology Journal*, 30(3), 195-232.
- Levin, J.R., Anglin, G.J., & Carney, R.N. (1987). On empirically validating functions of pictures in prose. In D.M. Willows & H.A. Houghton (Eds.), *The psychology of illustration: I. Basic research*. New York: Springer-Verlag.
- Wulfeck, W.H., Chang, F.R., & Montague, W.E. (1986). Document and display design. In T. Sticht, F. Chang, & S. Wood (Eds.) *Advances in reading/language research: Volume 4, Cognitive science and human resources management* (pp. 183-195). Greenwich, Conn: JAI Press.

## Formative Evaluation of Instruction

---

**Finding:** Tryouts of instruction determines where representative students have difficulty in understanding, where testing is needed, and instructional efficiency.

**Comments:** Instructional design and development of training results in the production of materials, recommended presentations, and laboratory hands-on experiences for trainees. Feedback from trainees is needed to test the adequacy of the planning and decisions made in devising training. The first step occurs during development. It identifies and removes the most obvious errors in the instruction, and obtains initial reactions to the content from trainees and prevents compounding design errors.

Trainees study the instruction and discuss any problems they encounter in the instruction with instructors or the instructional developers. This "formative evaluation" can identify where presentations are inadequate, and where students have learning difficulties. Information obtained from them can be used to revise presentations and place tests in instruction to enable instructors to detect and correct likely student difficulties before students proceed to learn more advanced material.

For a formative evaluation, participating trainees required background training but do not yet know the content in the developing materials is needed. Any one student may only study a portion of the materials. Questions should identify the trainee's perceptions and weaknesses and strengths of the materials: Is the instruction interesting? Do they understand what they are supposed to learn? Are the materials directly related to the stated objectives? Normally, the learner receives the tests developed for the section being evaluated. How long the learner takes to complete the material provided confirms or contradicts planning. This way developers find typographical errors, omissions of content, missing pages, and other kinds of mechanical difficulties. Learners describe difficulties they have with the learning sequence, the concepts, and the testing. This learner feedback can be extremely useful for a developer.

Subsequent, small- and large-group evaluation, or "summative" evaluation, confirms the effectiveness of the design and identify additional learning problems. Sub-groups of students of low, average, and high aptitude can be used to make sure the materials are adequate for the range of students expected.

- References:** Branson, R. K., & Grow, G. (1987). Instructional systems development. In R. M. Gagné (Ed.), *Instructional technology: Foundations* (pp. 397-428). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Cambre, M. A. (1981). Historical overview of formative evaluation of instructional media products. *Educational Communication and Technology Journal*, 29, 3-25.
- Dick, W., & Carey, L. (1985). *The systematic design of instruction*. (2nd edition). Glenview, IL: Scott-Foresman.
- Markle, S. M. (1967). Empirical testing of programs. In P. C. Lange (Ed.), *Programmed instruction: The sixty-sixth yearbook of the National Society for the Study of Education, Part II*. Chicago: University of Chicago Press.

## Using Simulation for Training

**Finding:** Effective simulation provides systematic practice, feedback about errors, depicts how a device or system works but, may violate physical and temporal fidelity.

**Comments:** Expensive simulators, physically faithful to actual equipment and events, may not provide as effective training as simple, partial-task trainers that simulate a few key features of the environment. The complexity of the tasks or equipment may prevent new trainees from keeping track of events, and the trainees often cannot "see" the results of their interactions with the simulated system. Events may occur so slowly that in the time allocated, little practice occurs. The system may not indicate how to correct any errors made.

Simulations intended to train novices may need to be designed quite differently than those intended to provide practice or retraining for modestly trained people. Novices need extensive guidance and precise corrective feedback to correct their errors, while trained people may need to hone their skills or broaden their knowledge of new and unusual situations, cues, or events that may be encountered. New learners need simplified examples of problems to facilitate their learning. They may need to have normally invisible events or processes displayed to promote understanding such as in showing the flows and adjustments made in hydraulic, steam pressure, or electrical systems.

Simulators offer many advantages in training. They are often cheaper (no fuel costs, etc.) for student-practice than the "real" task and equipment. Students can concentrate on more dangerous, critical, complex or difficult skills (e.g., practice takeoffs or complex maneuvers such as carrier-landings without having to take time to do less critical tasks like taxiing, enroute flight). Simulators can incorporate important training variables, and address the cognitive and or skill aspects of instruction. Based on observed student performance, the amount of practice can be varied, and the difficult task segments can be isolated and repeated. Partial simulators may be easier to learn from than the actual device or a physically faithful simulation because they may be programmed to depict normally invisible functions and events.

The effectiveness of a simulation results from the instructional methods incorporated into the device that support student learning rather than from any simple physical or functional similarity to an actual device. Thus, the design decisions are based, for example, on ways to isolate, or discriminate cues, and ways to provide time-compressed practice for skill development rather than on particular hardware or media.

- References:** Blaiwes, A. S., & Regan, J. J. (1986). Training devices: Concepts and progress. In J. A. Ellis (Ed.), *Military contributions to instructional technology* (pp. 83-170). New York: Praeger Publishers.
- Halff, H. M., Hollan, J. D. & Hutchins, E. L. (1986). Cognitive science and military training. *American Psychologist*, 41 (10), 1131-1139.
- Schneider, W., Vidulich, M. & Yeh, Y. (1982) Training spatial skills for air-traffic control. *Proceedings of the Human Factors Society* (pp. 10-14). Santa Monica, CA: Human Factors Society.
- Sample, C. A., Hennesy, R. T., Sanders, M. S., Cross, E. K., Beith, B. H., & McCauley, M. E. (1981, January). *Aircrew training devices: Fidelity features* (AFHRL-TR-80-36). Wright-Patterson Air Force Base, OH: Air Force Human Resources Laboratory, Logistics and Training Division.

## Criterion Referenced Testing

---

**Finding:** Testing needs to be geared closely to the goals of a training program.

**Comments:** Testing during and after instruction is used to indicate student progress, determine what students find difficult, and tailor individual assignments to overcome the difficulties. The testing, therefore, is focused on performance requirements, which are derived from analysis of the work trained individuals are expected to do. Various means of testing are used, including laboratory exercise performance, oral and written quizzes and tests, out-of-class assignments, classroom questions, and comprehensive performance tests.

Assessment needs to be as job-like as possible. Performance tests should be hands-on and pencil-and-paper tests of knowledge should be restricted to safety and knowledge critical for job performance. If workers use manuals and books to find the information needed to carry out a task on-the-job, open-book testing should be used.

Well designed, performance-oriented tests inform students about job requirements and guide their learning. Frequently tested students outperform less frequently tested ones. Students generally take two kinds of tests: knowledge tests and performance tests. Knowledge tests help instructors find out if the students have learned information important for safety and knowledge important for performance. Performance tests indicate student competence and provide information about both student and instruction inadequacies. Errors students make on tests and in class identify learning problems that need to be corrected. Instructors need this information to provide prompt feedback to students on their performance and assignments and to help correct any difficulties they may have.

**References:** Bangert-Drowns, R. L. (1986, April). Effects of frequent classroom testing. *American Educational Research Journal*.

Ellis, J. A. & Wulfeck II, W. H. (1982). *Handbook for testing in Navy schools* (NPRDC SR 83-2). San Diego, CA: Navy Personnel Research and Development Center. (AD-A122 479)

Ellis, J. A. & Wulfeck II, W. H. (1986). Criterion-referenced measurement in military technical training. In J. A. Ellis (Ed.), *Military contributions to instructional technology* (pp. 60-82). New York: Praeger Publishers.

Roid, G. & Haladyna, T. (1982). *A technology for test item writing*. New York: Academic Press.

Samson, G. E., Graue, M. E., Weinstein, T., & Walberg, H. J. (1984). Academic and occupational performance: A quantitative synthesis. *American Educational Research Journal*, 21(2), 311-321 (ERIC Document No. EJ 303 651)

## Maintaining Consistent Objectives, Testing, and Instruction

**Finding:** Course effectiveness and efficiency depend on the consistency between the training requirements, implied task requirements, objectives, and task statements and how instruction is presented.

**Comments:** The quality of a training program can be judged by examining course objectives. If the objectives are the result of an adequate analysis of training requirements, then it is possible to develop a relevant course and adequately test its students. With inadequate analysis, relevant objectives on which to base optimal instruction or testing cannot be identified.

Reviews of Navy courses reveal mismatches between required skills and the objectives indicating an inadequate analysis. Objectives are often misused in the design or presentation of the course materials. Irrelevant information may be presented. Required information, as reflected in the objectives, is too often missing from the course materials.

The objectives determine what the curriculum and testing should contain. Training requirements and objectives often specify one sort of performance as a goal of learning, but another is tested. For example, the objective "Given the weight of a thawed raw fowl and depending on whether or not the fowl is to be stuffed, the student will determine the optimum cooking time at 325 degrees fahrenheit to within three minutes" cannot be tested by tasting the bird, or having the student recognize the answer on a true-false test. The objective requires the calculation of an answer. Thus, a short answer, or fill-in test, is the best test for this objective.

An extensive study of 1986-87 Navy technical training courses in A, C, and F schools, indicates that as many as 56% of the training objectives are not appropriate. A major reason is that the required training standards are inappropriate; half of the objectives were not tested; less than half of the test items matched the objectives. It appears that Navy classrooms can be improved.

**References:** Ellis, J. A., & Wulfeck II, W. H. (1980, March). *Assuring objective-test consistency: A systematic procedure for constructing criterion-referenced tests* (NPRDC SR 80-15). San Diego, CA: Navy Personnel Research and Development Center.

Ellis, J. A. & Wulfeck II, W. H. (1982). *Handbook for testing in Navy schools* (NPRDC SR 83-2). San Diego, CA: Navy Personnel Research and Development Center. (AD-122 479)

Ellis, J. A. & Wulfeck II, W. H. (1986). Criterion-referenced measurement in military technical training. In J. A. Ellis (Ed.), *Military contributions to instructional technology* (pp. 60-82). New York: Praeger Publishers.

Montague, W. E., Ellis, J. A., & Wulfeck II, W. H. (1983). Instructional quality inventory: A formative evaluation tool for instructional development. *Performance and Instruction Journal*, 22(5), 11-14.

## Distributing Training over Time

---

**Finding:** Spacing learning or practice over several sessions separated by other activities makes training more effective than equal amounts of massed or concentrated practice.

**Comments:** Learners can absorb and integrate only a limited amount of new information at one time. Training can be made more effective by designing shorter lesson segments and distributing them in time by separating them with periods of other activities. Both non training or different-training activities can be interposed between scheduled sessions. For example, five classroom hours of lessons on quality control procedures will be learned best if they occur on five successive days rather than all on a single day.

Similarly, repetition of drill needed for developing skills can be made more effective by using short sessions separated by other drill activities. If, for example, trainees are learning code recognition, separating short blocks of practice trials by practice on other tasks or activities is more conducive to learning than when the practice is massed together.

Two "spaced" or distributed sessions are about twice as effective as two successive or massed sessions, and the difference between them increases as the number of repetitions increases. Achievement following massed practice sessions is often only slightly better than that following a single, shorter session.

### References:

- Dempster, F. N. (1987). Time and the production of classroom learning: Discerning implications from basic research. *Educational Psychologist*, 22(1), 1-21.
- Rothkopf, E. Z., & Coke, E. U. (1963). Repetition interval and rehearsal method in learning equivalence from written sentences. *Journal of Verbal Learning and Verbal Behavior*, 2, 406-416.
- Smith, S. M., & Rothkopf, E. Z. (1984). Contextual enrichment and distribution of practice in the classroom. *Cognition and instruction*, 1, 341-358.

## Cooperation Among Students in Learning

---

**Finding:** Students who help each other and work together learn more than do those who learn alone.

**Comments:** Promoting cooperation among students in training facilitates academic achievement. It is more effective than promoting interpersonal competition and individual effort to outshine others in class. It may also assist subsequent team activities as students learn to work together. Cooperative learning promotes positive feelings of personal worth and positive attitudes toward the course content.

Arranging peer interaction in small groups to supplement regular classroom and laboratory teaching helps slower and underachieving students to learn and succeed in school.

Peer cooperation can take a variety of forms: discussion groups, seminars, or tutorial groups led by teaching assistants; the proctor model, where senior students may assist individual students; student learning groups that are instructorless or self-directed; or senior students teaching entering students.

Student coaching is useful in raising achievement. The coaches benefit because they learn more about the material by preparing and giving lessons to others. The effect of coaching usually raises achievement test scores. The effects are greatest in long cognitive courses and extensive drill-and-practice courses. Short courses that stress test-taking show the least improvement from coaching methods. Classes that use tests at the start of the course report stronger coaching effects than classes giving tests only at the end.

Students bring many life experiences into the classroom, which should be acknowledged, tapped and used. They can learn well--and much--through cooperative study with respected peers.

**References:** Bangert-Drowns, R.L., Kulik, J.A., & Kulik, C.C. (1983, Winter). Effects of coaching programs on achievement test performance. *Review of Educational Research*, 53(4), 571-585.

Goldschmid, B., & Goldschmid, M. L. (1976). Peer teaching in higher education: A review. *Higher Education*, 5, 9-33.

Johnson, D.W., Maruyama, G., Johnson, R., & Nelson, D. (1981). Effects of cooperative, competitive, and individualistic goal structures on achievement: A meta-analysis. *Psychological Bulletin*, 89(1), 47-62.

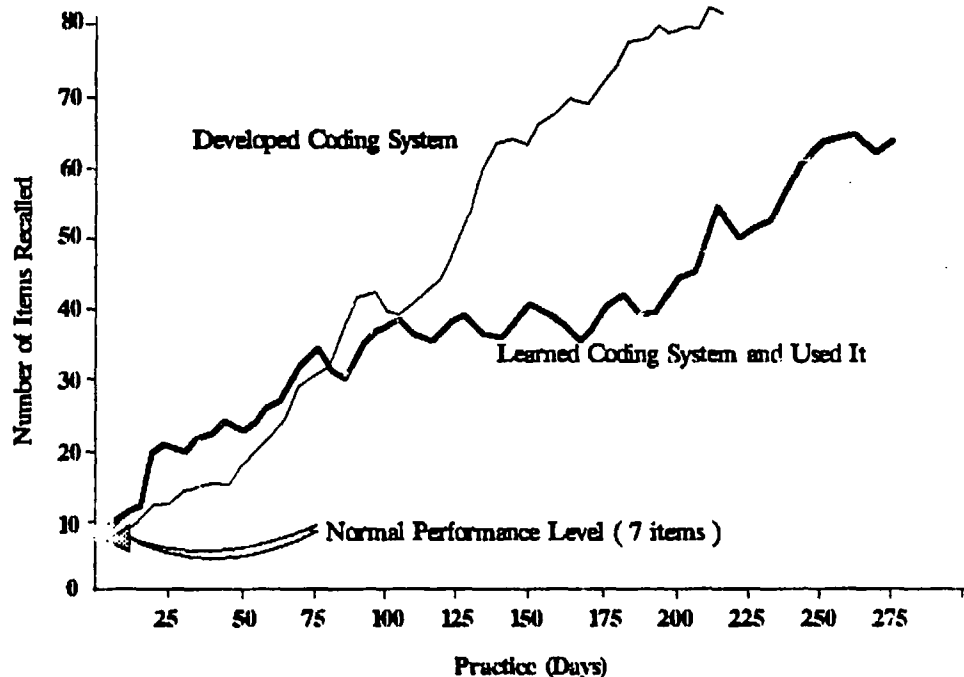
Slavin, R.E. (1983). *Cooperative learning*. New York: Longman, Inc.

Smith, K.A., Johnson, D.W., & Johnson, R.T. (1981). The use of cooperative learning groups in engineering education. In L.P. Grayson & J.M. Biedenbach (Eds.), *Proceedings: Tenth Annual Frontiers in Education Conference* (pp. 29-32). Washington, DC: American Society for Engineering Education.

## Coding and Practice

### Coding and practice result in exceptional memory performance.

Normally, people can recall immediately a string of about seven unrelated items like digits or letters presented to them one at a time. However, recall performance can be improved to many times that level by using a learning strategy such as coding items into more meaningful chunks and by practicing a lot.



The figure shows the recall data of two persons who learned a way to increase memory-span to exceptional performance levels. The lighter line presents data for a person who was read strings of digits and simply asked to recall them. He was a runner, knew much about running, running times and records for competition. As some digit groups reminded him of running times for different races, he began to code 3- and 4-digit groups as running times for various races (e.g., 3 4 9 2 was coded as 3 minutes and 49.2 seconds, near the world record time for a mile). As practice continued, he constructed other mnemonic associations along with the times, such as ages and dates. With the development of this coding scheme he was able to recall about 80 digits accurately after about 220 practice sessions.

Another runner was taught the memorization scheme. The darker line shows his performance on over 275 practice sessions. Both performed exceptionally. The important lesson is that coding schemes based on a person's existing knowledge are important learning strategies. Self-generated schemes are powerful tools in learning. Good ones can be useful to other learners, and provide them an early boost in performance. Furthermore, extensive practice is necessary to develop skill.

**Reference:** Ericsson, K. A. & Chase, W. G. (1982). Exceptional memory. *American Scientist*, 70(6).

## Memorization Aids

---

**Finding:** Mnemonic devices or coding systems help students recall important information when needed.

**Comments:** Learning by rote seems an inefficient way of remembering. When people are faced with a rote memory task, they often try to devise some scheme to make the learning task easier. Therefore, teaching students various types of memory devices or mnemonic procedures has often been proposed to make remembering materials easier.

Aids to memorization can take various forms which can be given to students. Some formal devices provide students with mental cuing structures that are made up of visual images or words in sentences or rhymes that mediate between a signal to the learner to recall and the information to be recalled. Students learn the cuing structure first and associate each item of new information with one or more of the already memorized cueing structures. Later, they use the structure for recall through a self-cuing process.

Usually, the cuing structure is not conceptually related to the information it cues. For example, consider the rhyming peg-word mnemonic system "One is a bun, Two is a shoe, Three is a tree, etc." Students first memorize the ordered rhymes. Then, when they must learn an arbitrary set of items in order, they relate the first with "bun," the second with "shoe", and so on. Instructions often suggest using visualization to help relate the items. Mnemonic devices are effective in helping students to recall unorganized names and procedural data.

Students can be encouraged to devise their own mnemonic devices such as a story to help recall a list of arbitrary words or phrases. Ship handlers have to remember colors of signal lights associated with marking intervals in distances between ships: for example, red (20 yards), yellow (40 yards), blue (60 yards), white (80 yards), green (100 yards). To remember the r y b w g sequence, students are asked to make up a sentence (or are given one). Thus, "rub your belly with grease" encodes the sequence, is memorable, and facilitates recall of the information.

**References:** Bellezza, F. S. (1981). Mnemonic devices: Classification, characteristics and criteria. *Review of Educational Research*, 51(2), 247-275.

Biaby, R., Kincaid, J. P., with Aagari, J. A. (1978, July). *Use of mnemonics in training materials: A guide for technical writers* (TAEG Report No. 60). Orlando, FL: Training Analysis and Evaluation Group.

Pressley, M., Levin, J., & Delaney, H. (1982). The mnemonic keyword method. *Review of Educational Research*, 52, 61-91.

Williams, S. S. (1979). Improving Memory: Developing imagery skills in returning adult students. *Adult Education*, 51(5), 286-92.

# Acknowledgements

---

## **Advisors-Research**

Prof. F. Knirk *University of Southern California*

Prof. J. A. Kulik *University of Michigan*

Prof. M. D. Merrill *Utah State University*

Dr. J. Orlansky *Institute for Defense Analyses*

Prof. E. Rothkopf *Columbia University*

Dr. T. Sticht *Applied Behavioral & Cognitive Sciences, Inc.*

Prof. H. Walberg *University of Illinois, Chicago*

## **Advisors-Navy**

Mrs. J. Hart *Chief of Naval Operations*

Mr. C. Hartz *Commander Training Command, Atlantic Fleet*

Dr. J. Haslett *Chief of Naval Education and Training*

Dr. H. Jellison *Commander Training Command, Pacific Fleet*

Mrs. D. Kalavoda *Naval Aviation Technical Center*

Mr. R. King *Naval Education and Training Program Management Support Activity*

Ms. V. Medley *Chief of Naval Technical Training*

Dr. E. Aiken *Navy Personnel Research and Development Center*

Ms. A. Crawford *Navy Personnel Research and Development Center*

Dr. J. A. Ellis *Navy Personnel Research and Development Center*

Lt. D. Gonzalez *Navy Personnel Research and Development Center*

Dr. B. McDonald *Navy Personnel Research and Development Center*

Dr. J. Vogt *Navy Personnel Research and Development Center*

## **Assistants**

Mr. J. Sole *San Diego State University*

Ms. K. Tinios *San Diego State University*

## **Editor**

Mrs. R. Ireland *Navy Personnel Research and Development Center*

# Information

---

*Obtaining*

*ERIC Documents*

*DTIC Documents*

*Ordering*

*Extra copies and*

*Providing*

*Comments*

---

## Obtaining Documents

---

Several of the references cited in this book include a document number from one of two document services. The following addresses are provided to assist readers interested in obtaining documents. Items without document numbers may be obtained through a nearby University or College library or with assistance at a municipal library.

**ERIC Documents:** The Educational Resources Information Center (ERIC) was established by the U.S. Office of Education as a national information system to collect, store, and disseminate information on education. It furnishes copies of filed reports at nominal cost in both microfiche and hard copy forms. Copies of documents can be ordered by accession number from:

ERIC Document Reproduction Service  
Computer Microfilm Corp.  
3900 Wheeler Avenue  
Alexandria, VA 22304  
1-800-227-3742 or (703) 823-0500

**DTIC Documents:** The Defense Technical Information Center (DTIC) is the central point within the Department of Defense for acquiring, storing, retrieving, and disseminating scientific and technical information primarily to support the conduct of research, development, engineering and studies programs. The Manpower and Training Research Information System (MATRIS) provides access to a specialized database of particular interest to people interested in military training and education research. Copies of documents can be ordered by accession number from:

Defense Technical Information Center  
Building 5, Cameron Station  
Alexandria, VA 22304-6145  
(202) 274-6434; Autocon 284-6434

**To order copies or provide comments --**

Use this form to request additional copies of the Summary or send comments and suggestions.

---

**ORDER FORM**

Please send \_\_\_\_\_ copies of *What works: Summary of Research Findings for Navy Instruction and Learning* to:

Name: \_\_\_\_\_

Address: \_\_\_\_\_

City: \_\_\_\_\_

State/Zip: \_\_\_\_\_

We intend to use the book for:

\_\_\_\_\_  
\_\_\_\_\_

For ordering copies, please tear this page out, complete the form and send it to the address provided.

For brief comments and suggestions use the space below. Use another sheet to provide additional comments as necessary. We are especially interested in comments on material you found useful (or not useful) and in your suggestions for additional information you would find useful in your work. Send the comments to the address below.

Comments:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Mail this Form to:

What Works  
Navy Personnel Research & Development Center  
San Diego, CA 92152-6800

---